THE

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THE PROTECTION OF EXPLOSIVES FACTORIES AND MAGAZINES FROM LIGHTNING.

ACCORDING to the Explosives Act, every "danger" building at places where gunpowder, dynamite, gun cotton or any of the "high explosives" are manufactured, must be provided with an efficient lightning conductor; but in spite of the Lightning Rod Conference, in which so many eminent men took part, the question as to what forms an efficient conductor in a factory where explosives are made is not yet definitely agreed upon.

The case of a factory for explosives is very different to that of an ordinary dwelling house, the conditions being in almost every respect unequal, hence what may prove an efficient protection for the latter, where an accidental disturbance may not do great harm, may for a workshop or magazine of explosives prove highly dangerous. The thorough and reliable examination of a lightning conductor can only be done by an electrical expert, and in an explosives factory, where sometimes a hundred of them have to be tested, this takes several days. Then, too, if a gale is blowing, or the factory is exposed to a sea atmosphere, the conductor may soon get out of order again.

Further, the presence of machinery in the buildings, the tram lines, pipe lines, overhead and underground, all imperil the safety which is supposed to accrue from the use of the usual type of lightning conductor upon buildings in which explosives are made or stored.

What is wanted is, that the subject shall receive a competent investigation with special reference to explosives factories, so that the best form of conductor shall be decided upon and rendered compulsory by Act of Parliament.

Mr. Oscar Guttmann said the other day, when the subject of explosives was being discussed at a meeting of the Society of Chemical Industry, that he had had some experience of Prof. Oliver Lodge's system of lightning conductors. [This system, by the way, he described as not new, a Belgian, M. Melsens, having been the first to make lightning conductors on the principle.]

This method of protecting buildings, it will be remembered, is based on the same principle as that by which electrometers are sometimes shielded by wire cages. A network of galvanised iron wire is placed around the building—a material far cheaper than copper or any copper alloy, and for electrical discharges of such high potential as lightning, equally effective.

Prof. Zenger, of Prague, has developed this system of protection from lightning, and it has been extensively tried by the Austrian military authorities. In that country, in the mountain region of the Karst, a thunderstorm was of very frequent occurrence—almost every day at certain seasons,

and the lightning struck in every direction. There are a number of exposed forts and military stores there containing gunpowder, ammunition, shells, &c., and the wire-cage system had been tried upon these magazines and found to be a very efficient protection. Colonel Ph. Hess placed in such a cage one of the bridge detonators employed for military purposes, which are so sensitive, that the smallest spark of electricity would fire them; but he could get no explosion, although he applied the sparks from a powerful Wimshurt machine.

Such evidence as this certainly makes in favour of the adoption of the cage system for all explosives factories or magazines. An explosion, due to lightning, occurred quite recently in a manufactory on the Continent, where the rod had been examined by an expert a few days only before the explosion occurred, and was therefore probably in perfect order. As Mr. Guttmann pointed out, comparatively little is known about the subject, and it is desirable that there should soon be some special enquiry. Meanwhile, it is to be hoped that the report of the Commission which has been at work in Germany for about two years will throw light upon it.

COAST COMMUNICATION.

The success we have always predicted attended Sir E. Birkbeck last Wednesday, when he brought his resolution on this matter before the House of Commons, which passed it without opposition, as reported last week. The matter had been so well brought to public notice through the untiring efforts of public spirited men and the cordial assistance of the press, that the Government not only undertook to do all that Sir E. Birkbeck asked, but Sir James Fergusson was able to announce that practical steps had already been taken in the work of establishing electrical communication with some of the most important coastguard and signal stations on the south coast of England, including Lundy Island, while estimates are to be got out without delay for the entire coastline.

The Postmaster-General alone seems to wince at the expense which, to the public mind, is certainly not great, and ought to have been incurred long ago, even had it been far greater.

The work will, we understand, be taken in hand by the Postal Telegraph Department, and there is no doubt that those who have laboured so long and untiringly to get the Government to sanction the necessary expenditure of money, will see that their scheme is carried out fully and efficiently. It should not be forgotten that these lines of communication will be expected to work under atmospheric conditions which too often prove disastrous to aerial lines. Bad weather is, indeed, almost their *raison d'être*, and it would never do to have them failing when most needed. It seems almost a pity that, considering the great use which will undoubtedly be made of them in time of war, the Admiralty do not take steps to secure their being all subterranean.

The establishing of communication with isolated rock lighthouses and lightships has been referred to a Royal Commission, not because the need of its being carried out is in question, but because there are difficulties in connection with it. For our part, we wish that Sir E. Birkbeck had treated this portion of his scheme of coast communication in the same way as that for the land-lines. We have always maintained that the difficulties are by no means insuperable, and, indeed, that the surmounting of them is simply a matter of the expenditure of the necessary money. In a moment of indiscretion, Sir James Fergusson stated that it had been roughly estimated that the cost of establishing electric communication with the 261 rock lighthouses and lightships along our coasts would be £300,000. This figure can surely not be considered anything but moderate; but no doubt the Royal Commission will decide that it is not necessary to connect up all the lightships. The fact that an estimate has been made would almost seem to indicate that the Post Office are already agreed as to the best way of doing the work.

To those interested in the technical details, we recommend a pamphlet recently written by Captain Benest on Coast Telegraph Communication,* which gives descriptions and drawings of numerous inventions which have been devised with the object of efficiently maintaining communication with rock lighthouses and lightships.

We notice that one of the methods suggested is a modification of the chain armour originally proposed by a correspondent of ours in our issue of February 12th.

There are some suggestions made by Captain Benest which we should severely criticise if we could afford the space, but, on the whole, the pamphlet is a very complete and interesting one, with quite a wealth of maps and drawings.

Armature Burn-Outs.

American electrical engineers owe much to a dry climate, but it appears that even this has occasionally its drawbacks. Mr. E. Stark, of the Manhattan Company, gives an interesting account of how a dry spell of weather cost his company, and others of New York, a very large number of armatures. It has many times been observed that driving-belts often become very highly charged owing to friction, &c., and may even be capable of exciting vacuum discharges in glow lamps or Geissler tubes. In the present case, however, the static charge did not content itself with such innocent performances, but the potential increased till sparks passed and punctured the armature insulation, and as the dynamos were high pressure machines, a burn-out followed. The remedy which first suggested itself of grounding the frame proved inadvisable, and so a Geissler tube which discharged at 3,000 volts was put in each grounding circuit, and the result was very successful. Fortunately (or is it unfortunately?) we are not troubled with such dry weather in this climate, so that this precaution will not probably be largely adopted in England.

Prevention of Sparking in Dynamos.

Our contemporary *L'Electricien* describes an ingenious method devised by M. Deprez for preventing sparking at the commutator of dynamos. The ordinary commutator is made in two parts placed side by side, and with the insulating parts occupying in each as much space as the bars, but alternating in position in the two halves. By means of two brushes on each side the current is collected much in the usual way; to prevent the sparking, these brushes are joined by a resistance, and the main circuit taken off from the middle of this resistance. By adding a battery of accumulators to this circuit of just sufficient E.M.F. to oppose the

* H. Alabaster, Gatehouse & Co., 22, Paternoster Row, E.C.

E.M.F. of the coil undergoing short circuit, M. Deprez has succeeded in running high pressure machines with absolutely no sparking. It is probably in machines of this type alone that it is quite worth while adopting such a device, which necessarily adds to the cost and difficulty of construction of that portion of the dynamo which is already costly and delicate. In ordinary low tension machines it would seem scarcely necessary to add this form of commutator, as under general circumstances the sparking is nearly nil.

Determining Electro-Magnetic Radiation.

AN ingenious method has recently been applied by Prof. Klemenčič to the determination of electro-magnetic radiation, by means of which he has obtained results agreeing with those of Boys, Briscoe, and Watson, when they used the convection air thermometer. The method used is so very different to that employed by these English physicists that a short account may be considered interesting. Essentially Klemenčič's method consisted in bringing a thermo-element near a fine platinum wire heated by the electric vibrations, and measuring the increase of temperature at the junction. In order to get comparative results the wire was also heated by a constant current and the rise of temperature at the junction also measured. In the first series of experiments a form of secondary inductor consisting of two thin brass plates, each 30 cm. in length and 5 cm. in breadth was employed, and the heating of a thin platinum wire 2 cm. long was investigated. The investigation showed a production of heat of 0·000155 calorie per second. Another series of experiments was carried out on a single platinum wire 26·0 cm. long, which was exposed to electro-magnetic radiation. This series gave as a value 0·000088 calorie per second. A "Hertz" mirror was used in both these series with a distance of 1·44 metres between the focal lines; the primary conductors corresponded to a wave-length of 66 cm.; the Rhumkorff coil was excited by three accumulators and the breaks were at the rate of 23 per second. The value found by Messrs. Boys, Briscoe and Watson works out to 0·000033 calorie per second.

The Rotary Field.

IT may be remembered by some of our readers that when the question of the relative values of the Tesla and the Drehstrom types of alternating motors was under discussion, it was advanced, in favour of the latter, that it produced a more constant rotary field: Mr. Kelly, of the Stanley Laboratory, points out the mistake in this from a kinematic point of view. Whether we have two sine curves with 90° phase, or three with 120° phase, we still get a constant rotary field, provided variation of permeability be neglected. Mr. Dobrowolsky alleged that the variation in field in the Tesla type was 40 per cent. If the two magneto-motive forces be truly in quadrature, one cannot see how the resulting one is variable at all. Of course, if the phase angle differ from 90°, the variation might become considerable. Mr. Kelly considers that Mr. Dobrowolsky has confounded the space variation with the time variation: if this be so, some of his other deductions are very likely to be in error, such as the power calculations, &c.

Vacuum Discharges.

DR. PUPIN, of Columbia College, has recently been investigating the mutual action of parallel vacuum discharges, and has arrived at some interesting results, although his work would appear to be somewhat unfinished. He finds that at high vacua two parallel streams in the same vessel have but little action on one another, but when the pressure increases to several millimetres, the streams exert a strong repulsion. If, however, they occur in different vessels, although still parallel, there is no mutual action. From this fact and certain other observations, Dr. Pupin considers that the more obvious explanation of an electrostatic repulsion is incorrect, and that the effect is due to a strain brought about by the peculiar temperature distribution.

Magnetic Theory.

THE New York *Electrical Engineer* publishes the first of a series of papers by Mr. Kennelly, on "The Theoretical Elements of Electro-dynamic Machinery." From the well known clearness and ability of the author, one would expect these articles to be drawn up with much perspicacity, and the first gives us further warrant for this expectation. We must defer further remarks till the series is complete.

The New Telephone Company.

WHEN a rival to the existing telephone service in London was suggested a rate ranging from £8 to £12 per annum was stated by the promotors to be amply sufficient. When we pointed out that the estimates required revision if the service were to be seriously undertaken, our criticisms were regarded as evidence of hostility. The New Telephone Company has now issued a circular in which the rate is fixed at £14, the higher rate being considered necessary because it is the intention of the company to adopt universally the twin-wire system, as far as possible, underground, the lower tariff having been suggested when the single-wire overhead method of construction appeared the only means of establishing a telephone exchange. It will be remembered by those whose memories are not conveniently short, that the underground service and the twin-wire service were both parts of the system which was so confidently stated to be possible at a maximum rate of £12. The company has done wisely and increased its chances of success by naming a higher figure. Perhaps, in time, it may see the wisdom of profiting by other of our criticisms and regarding our suggestions as the most friendly which have been tendered to it.

The Variation of the Dielectric Constant of Liquids according to their Temperature.

MONS. Negréano has recently been studying the variations in the value of the dielectric constant for certain liquids subjected to variations of temperature, and his results were presented in the form of a "note" by Mons. Lippmann at a meeting of the Paris Academy of Science on February 15th. The constants were measured by the aid of a condenser with five horizontal plates, of which four were fixed and one movable. The end plates and the middle one were charged by means of a small induction coil, and the two intermediary plates were put into communication with a quadrant electrometer. The liquid dielectric was contained in a "well" plate which was heated up to certain ascertained temperatures. Tables of results are given which can be consulted in the *Comptes Rendus*, and the following formulæ representing the variations of the dielectric constants with the temperature were deduced.

Benzene:

$$K_t = K_{15}\,[1 - 0{\cdot}001433\,(t-15) + 0{\cdot}0000253\,(t-15)^2]$$

Foluene:

$$K_t = K_{14}\,[1 - 0{\cdot}0019103\,(t-14) + 0{\cdot}0000539\,(t-14)^2]$$

Xylene:

$$K_t = K_{15}\,[1 - 0{\cdot}001392\,(t-15) + 0{\cdot}0000133\,(t-15)^2]$$

Within the limits of temperature studied by Mons. Negréano it appears that the dielectric constants for the three liquids examined, diminish in value with the temperature. The work was performed in the Physical Laboratory at Bucharest.

Power-Measurements.

IT would appear that the three-voltmeter and three-ammeter methods of measuring power were becoming known in America, as the New York *Electrical Engineer* publishes a simple proof of the generality of the methods devised by Prof. Ayrton and Dr. Sumpner for the measurement of the power given to any circuit. It is shown in a very simple manner that the formulæ used depend in no way on the shape of the P.D. or current curves, and depend solely on the non-inductive character of the auxiliary resistance.

ECONOMY IN PRIMARY BATTERIES EMPLOYED FOR GENERATING POWER.*

By A. E. KENNELLY.

This paper is offered for the purpose of presenting succinctly the conditions that determine the economical selection of batteries when the power that they will be required to furnish is known. The results, like all other numerical evaluations, should be regarded as guides, rather than as oracles, since the numerous special conditions that may be contingent to each individual case may often call for a modification of the general rule.

Our first determination may be the minimum number of cells that, having each a definite E.M.F., e, and internal resistance, r, will steadily supply a current of c ampères under a uniform pressure of v volts at battery terminals. Let the total number of cells required be N, and the number of equal rows or series into which these are divided be n.

These conditions give :

$$\frac{N\,e}{n} - \frac{N}{n^2}\,c\,r = v \qquad (1)$$

and thus

$$N = \frac{v\,n^2}{e\,n - c\,r} \qquad (2)$$

It is clear that we can have an infinite number of values for N, one for each value of n which is greater than $\frac{c\,r}{e}$.

If $c\,r < e$, or the drop in the cell caused by the required current is less than its E.M.F., a single row or series of cells in sufficient number can be made to supply the current, and $N = \frac{v}{e - c\,r}$ is a possible solution, though not, as we shall see, the most economical solution, unless it so happens that $c = \frac{e}{2\,r}$. If $c\,r$ is not less than e then evidently the current cannot be produced by any possible number of cells in one series. It will be necessary to add others in multiple.

Regarding N in equation (2) as the dependent and n as the independent variables, we obtain the minimum value of N by causing the first differential coefficient of N with respect to n to vanish while observing that the second coefficient then becomes positive. If this operation be performed, we find :

The series,
$$n = \frac{2\,c\,r}{e} \qquad (3)$$

The number in each series,
$$\frac{N}{n} = \frac{2\,v}{e} \qquad (4)$$

The total number,
$$N = 4\,v\,c\,\frac{r}{e^2} \qquad (5)$$

As an example, suppose that it is required to produce 10 ampères under 8 volts steadily at the terminals of a battery whose E.M.F. is 2 volts and internal resistance 0·2 ohm per cell.

The minimum number of cells is needed :

Here,
$$n = \frac{2 \times 10 \times 0{\cdot}2}{2} = 2\,;$$

and,
$$N = \frac{4 \times 8 \times 10 \times 0{\cdot}2}{2 \times 2} = 16\,;$$

so that 16 cells should be used in two parallel series of eight each. The E.M.F. and resistance of each row would be 16 volts and 1·6 ohms ; so that, jointly, the battery would have 16 volts and 0·8 ohm and be capable of meeting the specified conditions, yielding 8 watts externally at an efficiency of 50 per cent.

As another example, let 15 ampères be required at 2 volts from a battery of 1·41 volts E.M.F., and 0·3 ohm per cell.

Here,
$$N = \frac{4 \times 2 \times 15 \times 0{\cdot}3}{1{\cdot}41 \times 1{\cdot}41} = 18$$

and
$$n = \frac{2 \times 15 \times 0{\cdot}3}{2} = 4{\cdot}5.$$

In this case the results are not whole numbers, and selection has to fall upon the nearest integers by trial. Thus :

Sixteen cells in four series of four give jointly 5·64 volts and 0·3 ohm, supplying 15 ampères at only 1·14 volts ; but 20 cells in five series of four give jointly 5·64 volts and 0·24 ohm, supplying 15 ampères at 2·04 volts with an efficiency of 36 per cent.

It is also evident, on inspection, that whenever formulæ (3), (4) and (5) yield integral results and not fractional numbers, the fall of potential in the battery at work will be equal to the external P.D., or that the working efficiency will be 50 per cent. This is also the well-known condition that the output of the given number of cells shall be a maximum. The condition for a minimum number of cells is, in fact, coincident with the condition that those cells shall develop a maximum output, and operate at 50 per cent. efficiency.

Next, suppose that instead of requiring a definite number of volts and ampères, we are content to take the product and specify for this amount of energy without defining the pressure, with a view to ascertaining whether the range of values thus afforded affects in any way the minimum number of cells required. For instance, instead of asking for 10 volts and 8 ampères in the last example, suppose 80 watts only to be in demand.

With this object in view, we readily obtain from equation (1), calling P the amount of power desired, stated in watts

$$N = 4\,P\,\frac{r}{e^2}, \qquad (6)$$

which is the same result as that in question (5).

n is now indefinite. This shows that the total minimum number of cells required for the development of a given power is independent of the pressure, when the supply takes place at battery terminals ; and that there are twice as many independent values of n as there are pairs of factors in N ; each such combination will supply the same amount of activity with the maximum output, and 50 per cent. efficiency. For instance, let 400 watts be required from cells having each 2·0 volts and 0·1 ohm.

In this case :

$$N = \frac{4 \times 400 \times 0{\cdot}1}{2 \times 2} = 40.$$

There are eight ways in which the 40 cells can be arranged.

	Cells.		Volts.		Ohms.				Per cent.
1 row of	40	E.M.F.,	80	res.,	4	c = 10;	v = 40;	eff. =	50
2 rows of	20	„	40	„	7	= 20;	20;		„
4 „	10	„	20	„	0·25	= 40;	10;		„
5 „	8	„	16	„	0·16	= 50;	8;		„
8 „	5	„	10	„	0·06254	= 80;	5;		„
10 „	4	„	8	„	0·04	= 100;	4;		„
20 „	2	„	4	„	0·01	= 200;	2;		„
40 „	1	„	2	„	0·0025	= 400;	1;		„

Each of these ways complies with the conditions. If however, N is yielded by the formula in fractional form, an approximation can be resorted to with the addition of a few extra cells. If N is a prime number, then only one single series of this number of cells will fulfil the conditions exactly, but a few more added will generally allow of sub-division into parallels, if desired. All departure from the strict minimum alters of course the efficiency.

We have so far considered the number of cells only, but if p be the purchasing price of each cell, the minimum first cost of a battery that will develop P watts is

$$N\,p = 4\,P\,\frac{p\,r}{e^2} \qquad (7)$$

From this it follows that the electrical value of any cell (assuming the absence of polarisation and local action) for purposes of generating power varies as $\frac{e^2}{r}$, for we have seen that the number of cells required is $\frac{4\,p}{\frac{e^2}{r}}$. If one type of cell has 0·5 volt and 0·05 ohm while another has 2 volts and 0·8 ohm, their electrical values will be equal, since the same number of each must be selected in order to develop a given amount of external activity.

This rule is the same as that which governs the rating of dynamos and motors, their relative electrical value depends

* New York *Electrical Engineer*.

in every case upon the value of their $\frac{e^2}{r}$, no matter what the nature of the winding in the armature of one, or the nature of the chemicals in the solution of the other; and $\frac{e^2}{r}$ is the power in watts that would be developed in the armature or in the cell if active on short circuit. Also the maximum output is reached in dynamos, motors, and batteries, when the exernal and internal activities equate, giving 50 per cent. electrical efficiency, the same rule determining in each case the minimum of plant and the maximum of output.* There is this difference, however, that dynamos and motors are worked at a much higher efficiency than 50 per cent. in practice, not only because it is economical to do so, but because they would become too hot if they did not, and the useful output of such machines instead of being 0·5, the condition of greatest output, varies from, say, 0·25, with 75 per cent. electrical efficiency in the smallest dynamos or motors, up to 0·02 with 98 per cent. of electrical efficiency in large multipolars. The practice with batteries has hitherto not been in the direction of such high efficiencies, and there is usually no danger of overheating them.

Again, the economical purchasing value of machines and batteries, depends so far as electrical qualifications are concerned on the value of the fraction $\frac{e^2}{p\,r}$ or what might be termed the short-circuit activity per dollar of cost. Two types of cell, one having an E.M.F. of 2 volts, and a resistance of 1 ohm costing \$1, and the other 0·7 volt and 0·05 ohm costing \$1.50, would compare in economic value for the production of power in the ratio of $\frac{4}{1}$ to $\frac{0{\cdot}49}{0{\cdot}075}$, or as 4 to 6·5, and the installation cost with the latter type would therefore be only 61 per cent. of that with the former for any specified activity, while independently of cost, the electrical values of the two would be in the ratio of $\frac{4}{1}$ to $\frac{0{\cdot}49}{0{\cdot}5}$, or 4 to 9·8. That is to say, the cell of lower E.M.F. would, by reason of its more than compensatingly lower resistance, be equivalent to nearly 2½ cells of the 2-volt type.

It frequently happens that a type of cell is made in several sizes at different prices, allowing a certain range of selection as to ampère capacity. In such cases the economic first cost value, or watts on short circuit per dollar will generally vary, and that size which makes this number a maximum is the most economcal to employ, other things being equal. In regard to cost of operation and maintenance, however, the ampère-hour capacity and lifetime have to be taken into separate account. Thus, in the case of two sizes of one type of cell, each having 2·0 volts, but the first with 0·9 ohm resistance costing \$1, the second having 0·3 ohm and costing \$1.75, the economic value of installation would compare between them in the ratio of $\frac{2\times 2}{1\times 0{\cdot}9}$ to $\frac{2\times 2}{1{\cdot}75\times 0{\cdot}3}$, or 4·44 to 7·62; and 44 of the larger cells would represent in value 76 smaller, while independently of cost, the equivalents being $\frac{2\times 2}{0{\cdot}9}$ to $\frac{2\times 2}{0{\cdot}3}$ or 4·44 to 13·3, one large cell would replace three small ones.

Hitherto we have devoted attention to minimum first cost, but may now consider the conditions that regulate the economy in the total cost of operation. If p be, as thus far assumed, the purchasing price of one cell, then the annual interest and depreciation on this price can be estimated. Call this sum s (dollars). Also from the capacity of the cell in ampère-hours and the cost of renewal, supposed known, find the cost of an ampère-hour in labour and material. Let this sum be denoted by q (dollars. Let h be the number of hours during which the battery is supposed to work at full load during one year. Then, if o be the total annual cost of operation, we have

$$o = N s + \frac{N}{n} c\,h\,q \qquad (8)$$

Substituting the value of N from (2) we find

$$o = v\,n\left(\frac{n\,s + c\,h\,q}{e\,n - c\,r}\right). \qquad (9)$$

Differentiating for a minimum it follows that

$$N = \frac{v\,c\,r}{e^2}\,\frac{(1+a)^2}{a} \qquad (10)$$

$$n = \frac{c\,r}{e}(1+a) \qquad (11)$$

$$\frac{N}{n} = \frac{v}{e}\,\frac{(1+a)}{a} \qquad (12)$$

where a is the positive value of the surd quantity $\sqrt{1+\frac{e\,q\,h}{r\,s}}$

Consequently,

$$o = \frac{v\,c\,r\,s}{e^2\,a}(1+a)^2 + \frac{v\,c\,h\,q}{e\,a}(1+a), \qquad (13)$$

and since the total number of watt-hours supplied in the year is expected to be $v\,c\,h$, the cost per watt-hour w is

$$w = \frac{o}{v\,c\,h} = \frac{r\,s\,(1+a)^2}{e^2\,a\,h} + \frac{q\,(1+a)}{e\,a}, \qquad (14)$$

while the efficiency of delivery is $\frac{a}{1+a}$.

Equation (14) is as fundamental in the theory of economy of operation as the criterion $\frac{e^2}{p\,r}$ is vital in questions of first cost. It shows that when h becomes large, that is to say, when the battery is worked much and continuously, the first term in the cost diminishes in importance compared with the second, and the cost of a watt-hour tends to approach the limit $\frac{q}{e}$ the efficiency tending at the same time to a high value. With batteries worked discontinuously and for short periods at a time, the criterion of economic value in operation tends to the fraction $\frac{e^2}{r\,s}$ or, what serves the same purpose in nearly every case, the $\frac{e^2}{p\,r}$ already found for first cost. On the other hand, for long and steady work in batteries the criterion tends to the fraction $\frac{e}{q}$ and so long as the internal resistance does not become unreasonably high, the E.M.F. of the cell per dollar of one ampère-hour's renewal becomes the leading factor. It so seldom happens in practice, however, that batteries are employed in long-continued hard work, that the latter criterion is seldom needed, but it is obvious that the more work is demanded from a battery in a given time the more economical it becomes to add to the first cost by more parallel series of cells reducing the joint resistance, and increasing the efficiency of delivery, which is in all cases measured by the ratio $\frac{v\,n}{N\,e}$.

As an instance, suppose that 8 ampères are needed during 100 hours in a year under a pressure at terminals of 16 volts from cells having 1·6 volts and 0·2 ohm each, their price \$1.50, interest plus depreciation being 13⅓ per cent. per annum and the cost of renewals estimated at \$0·0048 per ampère-hour per cell.

Here $v = 16$, $c = 8$, $e = 1{\cdot}6$, $r = 0{\cdot}2$, $q = 0{\cdot}0048$, $s = 0{\cdot}2$.

$$a = \sqrt{1+\frac{2\times 0{\cdot}0048\times 100}{0{\cdot}2\times 0{\cdot}2}} = \sqrt{25} = 5.$$

$$n = \frac{8\times 0{\cdot}2}{1{\cdot}6}(5+1) = 6\,;\ \frac{N}{n} = \frac{16}{1{\cdot}6}\times\frac{6}{5} = 12$$

$N = 6\times 12 = 72$; efficiency $= \frac{5}{6} = 83\frac{1}{3}$ per cent.

O

* The addition of field excitation, and the variation in the ratio of insulation thickness to diameter of conductor in different windings for an armature, introduce disturbing elements into the strict rating of a dynamo by its $\frac{e^2}{r}$. The rule is, however, sufficiently accurate for all ordinary purposes.

E.M.F. of battery 19·2 volts; joint resistance, 0·4 ohm; drop of potential, 3·2 volts; cost of battery, $108; annual cost (interest and depreciation), $14·40; ampère-hours supplied, 800 from 12 sets, or 9,600 cell ampère-hours; cost of renewals, $46.08; total annual cost, $60.48; power, 128 watts; total work done, 12,800 watt-hours; cost per watt-hour, $0.004725.

By formula, cost per watt-hour,

$$w = \frac{0{\cdot}2 \times 0{\cdot}2 \times 6 \times 6}{1{\cdot}6 \times 1{\cdot}6 \times 5 \times 100} + \frac{0{\cdot}0048 \times 6}{1{\cdot}6 \times 5} = 0{\cdot}001125 + 0{\cdot}0036 = 0{\cdot}004725.$$

If the most economical installation, only, had been sought for, formulæ (3), (4), and (5) give

$$n = \frac{2 \times 8 \times 0{\cdot}2}{1{\cdot}6} = 2; \frac{N}{n} = \frac{2 \times 16}{1{\cdot}6} = 20; N = 20 \times 2 = 40.$$

E.M.F., 32 volts; resistance of battery, 2 ohms; first cost, $60; annual cost, $8.0; total ampère-hours, 800, from 20 sets, or 16,000 cell ampère-hours; cost of renewals, $76.80; total annual cost, $84.80; work done, 12,800 watt-hours; cost per watt-hour, $0.006626.

Thus far we have supposed that the power to be utilised was taken at the battery terminals, or that if leads were taken from the battery to the work, the resistance of those leads was negligibly small. It becomes desirable to ascertain in what degree the conclusions already reached are affected by the introduction of sensible resistance in conductors that may intervene between battery and delivery.

Calling the resistances of the two leads together, t, equation (1) becomes:

$$\frac{N}{n} e - \frac{N}{n^2} c r - c t = v, \qquad (15)$$

and the solution for this for a minimum in N gives:

$$N = \frac{1}{4} c (v + c t) \frac{r}{e^2} \qquad (16)$$

$$\frac{N}{n} = \frac{2 (v + c t)}{e} \qquad (17) \qquad n = \frac{2 c r}{e} \qquad (18)$$

These equations show that as regards first installation, for given values of v, c, and t, the electrical value of the cell is subject to the same criterion, as in previous cases, namely, $\frac{e^2}{r}$, and since the cost of the battery will be $N p$, the economic first cost value of the cells is determined by the fraction $\frac{e_2}{p r}$, as before. It is evident, however, that the total number of cells required is no longer independent of the pressure, as was seen to be the case when no resistance existed in the leads, and the loss of energy in any given pair of conductors will be increased by lowering the pressure of supply. Formulæ (16), (17), and (18) give, however, the minimum number of cells and thus the minimum outlay when the pressure and current are specified through leads of known resistance.

Taking, for example, the first case mentioned, of 10 ampères needed at 8 volts with cells of 2 volts E.M.F. and 0·2 resistance, but with leads in circuit whose resistance t is 0·2 ohm, we have:

$$N = 4 \times 10 [8 + (10 \times 0{\cdot}2 \times)] \frac{0{\cdot}2}{2 \times 2} = 20;$$

$$n = \frac{2 \times 10 \times 0{\cdot}2}{2} = 2{\cdot}0$$

and 20 cells in two series of ten each, will fill the requirements and represents the minimum outlay.

As regards economy in operation, there is no difficulty in extending the above processes to determine the number of cells and the size of conductors that shall make the total cost of operation a minimum, but the formulæ becomes so complex that there is no practical advantage in developing them. It is evident, however, that since power from a battery is expensive, relatively, it becomes economical to employ heavy leads and by some extra first cost in conductors keep the loss in transmission as low as possible. It also becomes possible to reduce the case of economy of operation through leads, to economy of operation without leads, at least for uniform load, by adding to the power absorbed in the motor or other working device, the power that will at the full load current be lost in selected conductors, and assuming that the sum of these two is power taken at battery terminals as before.

To sum up, we have examined the conditions that regulate the economy of installation and of operation in batteries intended for a prescribed amount of work. The space that a battery will occupy, the attention that it may be expected to require, its local action, and polarisation, are all factors that have to be taken into separate account for each individual case, but the following leading facts are to be recognised.

1. The electrical value of a cell for doing work is measured by its $\frac{e^2}{r}$ or, the power in watts it can expend internally when short circuited.

2. The economical value as regards first cost and installation of a cell for doing work is measured by its $\frac{e^2}{p r}$ or the power in watts on short circuit per dollar of price.

These rules hold whether there is sensible resistance in the leads or not.

3. The conditions of minimum installation and minimum first cost involve those of maximum output, with a working efficiency of 50 per cent.

4, The economic criterion of a cell as regards operating expenses depends upon the continuity or intermittence of its work. For light work it is measured by $\frac{e^2}{p r}$ or watts on short circuit per dollar of price as in the case of first cost. For heavy, sustained work the criterion becomes $\frac{e}{q}$, or the E.M.F. of a cell per dollar of renewal expense on one ampère-hour. For any given case the comparison can be effected by formula (14).

To find the minimum installation and first cost for a given power with negligible resistance in leads, formulæ (3), (4), (5) and (6), may be used.

If minimum cost of operation is sought for and not minimum first cost, formulæ (10), (11), (12) and (13) apply, with the addition to the power needed of the power lost in leads, if these have sensible resistance. The minimum installation for the case of leads having sensible resistance is specially dealt with in formulæ (16), (17) and (18).

ELECTRIC LIGHT IN MEDICINE.

[FROM OUR OWN CORRESPONDENT.]

There recently died at Vienna the mechanician, Josef Leiter, a man who, in concert with eminent physicians, spent many years of his life in zealous study and experiment in order to realise one of the most modern and remarkable ideas of medical science. He was engaged with the solution of the question how far the interior of the human body can be made accessible to the eye of the physician. Before his death he had the satisfaction of knowing that his merits were fully acknowledged in a recent work by the distinguished neurologist, Prof. Lewandowski.

The medical world is already able to illuminate the interior of the mouth, the pharynx, the stomach, eye and ear, with the electric light. This is effected either by the direct introduction of the source of light into the organs concerned, or by the reflection of the light. At first the light of incandesced platinum wire was used, but latterly the well-known carbon filaments of the glow-light have been universally employed. The "mignon" glow-lamps, scarcely larger than an ordinary pea, were first shown at the Vienna Electrical Exhibition, and were successfully adapted to this use by Leiter. A number of apparatus for both methods of introducing the electric light (direct and by reflection) have been devised. The instruments for the use of reflected light do not differ in principle from those used for solar light. The electric light has, however, the advantage that the medical expert is rendered independent of the freaks of the weather. This principle can of course be combined in all possible manners with concentrating lenses, reflectors, &c. The first

such apparatus of this kind emanated from Vienna, where they were executed in 1883 by the optician Jirasko, at the instigation of Prof. Mosetti von Moorhof.

In the direct introduction of light we distinguish two modifications, illumination properly so-called, and diaphonoscopy. This latter method depends on the fact that human flesh is, in thin layers, translucent. If we hold up the open hand with the fingers close together before a brilliant light (not otherwise visible to the observer), the fingers appear at their margins translucent, and transmit a reddish light. This method is used in dentistry. The patient bites a small gag of vulcanite, the lateral process of which, projecting into the mouth, supports a mignon lamp. The interior of the mouth is brilliantly illuminated, and the dentist can look into the inside of the tooth and detect any morbid changes in the enamel, the dentine, the roots, the gums, &c.

The most interesting method at present is that by which the light is directly introduced into the cavities and passages of the body. In examinations of the pharynx a mignon lamp is placed in the shaft of the mirror and the rays are allowed to fall into the pharynx, which is thus brilliantly illuminated and reflected to the eye of the observer. Much more complicated is the introduction of light into the stomach, which is first evacuated by means of the stomach pump and afterwards expanded with air after the apparatus has been introduced. This apparatus is a long tube which has at its closed lower end a glass window, behind which is placed a mignon lamp connected with the battery by wires. When the current is turned on the filament becomes ignited, and illuminates through the window the interior of the body, which a small mirror makes the illuminated parts visible to the observer.

Very favourable reports on the results of such investigations have already been furnished by Profs. Oser and Mikulicz.

It will be perceived that the electric light plays already a not unimportant part in the art of healing, although we see only the beginning of its career.

AUSTRALIAN ELECTRICAL NOTES.

[FROM OUR OWN CORRESPONDENT.]

AT Redfern, in three places, the electric light mains cross the telegraph and telephone wires, and, to avoid any possible danger of contact between the Corporation's high tension mains and the Government wires, the former have been placed underground at the crossings. The Callender-Webber system has been adopted, and a total length of 260 yards of four-way casing laid. The cables used were Callender lead-covered, and were carried right up the poles in heavy wood casing, and jointed to the overhead mains in terminal boxes on the top of the pole, the overhead cables being led into the terminal box through Johnson and Phillips's fluid "leading-in insulators." At one point the conduit was laid across the Evaleigh Railway Bridge, and the maximum depth available was only 6 inches. The work was carried out for the contractors, the Williamson Electrical and Engineering Company, by Mr. Jas. O. Callender. This is the first bit of underground electric light conduit in the colony which has been laid for real work. An order has gone home for the same amount of work to be done at Newcastle for the same purpose—to avoid contact with the Government telegraph and telephone lines. A slight difficulty arose recently, in connection with the lighting of Newcastle, between the Borough Council and the contractors. It appears that at a recent meeting of the council a communication was received from the contractors, Messrs. Westcott, Marshall & Adams, asking when the council would decide about the taking over of the plant, as the year during which they had guaranteed to run it was nearly up; and the council decided not to take over the plant, owing to the unsatisfactory way that it had been working. It is only fair to state that there have been considerable alterations made; the original contract was for the maintenance of 300 incandescent lamps, for which £1,150 per annum was to be paid, but this number was subsequently altered to 250 incandescent lamps, and 20 arc lamps, and on January 7th, 1891, it was again altered to 320 incandescent lamps and 32 arcs, at which time the plant was running, and since then the number of arc lamps has been increased to 78; so that perhaps there may yet be an amicable arrangement.

The Postal Conference commenced at Hobart on Tuesday, March 22nd, and one of the subjects to be discussed was the question of subsidising the proposed Pacific cable. The Queensland Executive Council have confirmed their decision to accept the proposals of Mr. Audley Coote for the construction of the first section, from Gladstone to New Caledonia, of the Pacific cable, to connect Australia with the American continent. This was of course subject to the approval of the New South Wales Government, who have since agreed to subsidise the cable to New Caledonia to the extent of £2,000 per annum, provided Government messages are sent free.

Pending the erection of the electrical engineering laboratory at the new Technical College, Mr. F. B. Suttor, Minister for Public Instruction, has approved of a course of 84 technical lectures on electrical engineering being delivered between February and November of this year. The first term will be from February to May, in the course of which 28 lectures are to be given on the fundamental principles of electricity and magnetism, as specially applied to electrical engineering, the methods and instruments used for commercial measurements, electrical testing, and the industrial applications of electricity. The second term will extend from May to August, when a further 28 lectures will be on the principles, construction, and management of direct current dynamos, systems of direct current distribution, accumulators, direct current motors and their applications, and classes of engines and boilers suitable for driving an electrical plant. The third term, from August to November, will include 28 lectures on the principles, construction, and management of alternating current dynamos, systems of distribution by transformers, alternate current lighting, high tension mains, alternating current motors and the transmission of power, dynamo, engine and boiler testing, and the efficiency and relative economy of electrical plant. It is a very extensive course for one year, especially for an evening course. Half-a-dozen types of dynamos have already been put in position, and a testing laboratory, &c., is to be commenced as early as possible. Mr. Arthur C. F. Webb, M.I.E.E., has been appointed as lecturer, and has already delivered some nine or ten lectures. That the subject is popular is shown by the fact that there are over 90 students on the class-roll, with an average attendance of over 70. The tenders for the lighting of Perth (W.A.) closed on March 1st, but the result has not yet come to hand.

CHEMICAL EQUILIBRIUM IN MIXED ELECTROLYTES.

IN various researches* Dr. Gore, F.R.S., has shown that any change occurring in the molecular or chemical constitution of an electrolyte may be easily and quickly detected, and its amount and rate to a certain extent measured, either by the voltaic balance method, or by the simple plan of immersing a suitable voltaic pair of metals in the liquid successively at different periods of time, and noting either the degree of voltaic energy, electromotive force, or strength of current produced. He has also demonstrated that in certain cases the mixture of electrolytes, especially that of an aqueous solution of a halogen with one of a salt or base (and in some cases a very dilute solution of an acid with one of a salt), the liquid mixture does not at once attain its final or fixed state at 16° C., but attains it rapidly on the application of heat.

More recently in an investigation on change of electromotive force volume and temperature by mixing electrolytes† which has been noticed at length in the ELECTRICAL REVIEW, Dr. Gore has shown that if, instead of a single mixture of two solutions, a couple of such mixtures isomeric with each other (for instance, HCl + Na Br, and HBr + Na Cl), was employed, under certain conditions, in all the

* *Proc. Roy. Soc.*, March 14th, 1890, p. 440. *Phil. Mag.*, October 1889, p. 289. *Phil. Mag.*, January, 1892, p. 28.

† *Proc. Birm. Phil. Soc.*, Vol. viii., p. 28.

twenty-five cases of mixtures of acids + salts, and of salts + salts which were examined, the two mixtures yielded the same amount of electromotive force, and therefore formed the same final product during the act of mixing. In each case the ingredients of the two mixtures started with different total amounts of energy, but arrived at the same final molecular and chemical constitution; each different isomeric couple, however, gave a different final amount.

In other researches Dr. Gore has found that if the solutions were extremely dilute, and the "voltaic balance" method was employed, one of the two mixtures did not at once pass to the same final state, but gave a very different amount of voltaic energy from the other, especially if a free halogen formed part of the mixture. A list of unstable mixtures, as found by this method, has been given in a paper entitled "Relative amounts of available voltaic energy of aqueous solutions."*

Dr. Gore has still more recently been devoting his attention to the circumstances which influence the conditions of instability and of chemical and molecular equilibrium of such mixtures, and the results of his research occupy about 10 pages in the April number of the *Philosophical Magazine*.

The circumstances examined were :—

1. The influence of a halogen and a salt.
2. " " " " " two salts.
3. " " " time upon the latter.
4. " " " heating such a mixture.
5. " " " doubling the amount of the halogen.
6. " " " halving " " " two salts.
7. " " " two halogens and a salt.
8. " " " a halogen and an acid.
9. " " " two halogens and an acid.
10. " " " one halogen and two acids.
11. The influence of halogens and an alkali with aluminium, tin and zinc, as positive metals.
12. The influence of heating the halogens with an alkali.

The method used in this investigation for measuring the electromotive force was that of opposition with a thermopile of iron and German silver, and an astatic galvanometer as in several previous researches.†

Dr. Gore's results are collected in 15 tables; for these the reader must consult the *Phil. Mag.*, as they are too lengthy for quotation here. We are chiefly concerned with the object, the methods, and the conclusions of the investigation, but it is interesting to notice that the results may be grouped as follows :—

Section A.—Halogens + Salts (positive metal = zinc).

Table 1.—Influence of halogen + salt.
" 2. " " " + two salts.
" 3. " " time.
" 4. " " heating.
" 5. " " doubling amount of halogen.
" 6. " " halving amount of salts.
" 7. " " two halogens + salts.

Section B.—Halogens + Acids (positive metal, zinc).

Table 8.—Influence of halogen + acid.
" 9. " " two halogens + acid.
" 10. " " halogen + two acids.

Section C.—Halogens + Bases.

Table 11.—With aluminium as positive metal.
" 12.—With tin as positive metal.
" 13.—Chlorine water + potash
" 14.—Bromine " " " } with zinc as positive metal.
" 15.—Iodine " " "

The mixtures employed by Dr. Gore in this research may be divided into two classes, namely—

1. Those which spontaneously change with such rapidity that they at once attain on mixing a comparatively fixed state of chemical and molecular equilibrium.
2. Those which slowly change and attain this state.

The results, taken with those of previous investigations, show that with mixtures of acids + salts, and of salts + salts, a fixed state of equilibrium is in nearly all cases immediately attained; but with halogens + salts, halogens + acids and halogens + bases, a greater or less degree of retardation of attainment of such a state frequently happened.

When the results under Tables 5 and 6 are compared with those in Table 1, it appears that doubling the degree of concentration of the solution does not produce any conspicuous effect upon the state of chemical equilibrium.

The results under Table 3 indicate that with the particular mixtures there employed, a gradual change by lapse of time occurred, and each liquid attained a state of comparative equilibrium in twenty-four hours.

The influence of temperature is seen to be great on examining the results in a number of cases in Tables, 4, 11, 12, 13, 14, 15. In all cases it acted so as to promote chemical and molecular change, and enabled the mixtures to arrive at a fixed state. In all these cases there was a relative *loss* of electromotive force, and a more fixed state of chemical equilibrium was attained. The results of previous experiments* show that the action of the higher temperature was upon the halogens present.

The results under Table 1 show that if the ingredients of a mixture of a halogen and a salt in water were in the proportion of their chemical equivalents, the complete change and attainment of a fixed condition of equilibrium was promoted. If, however, as in Table 2, the saline ingredient was in excess, this change was retarded. But if, as in Tables 5 and 6, the electro-negative one was in excess, the change was not retarded.

Mixtures of halogens and acids in chemically equivalent proportions (as in Table 8) acted much like those of halogens and salts (as in Table 1), *i.e.*, their solutions at once attained a fixed or final state of chemical equilibrium on mixing; but an additional acid, like an additional salt, retarded chemical change (as in Table 10).

On comparing the results under Tables 1 and 2 with those under Tables 7 and 9, it appears that whilst doubling the proportion of salt to halogens retards the charge, doubling that of the halogens had not such effect.

Comparison of the results given under Tables 13, 14, and 15, with those obtained with solutions of the halogen alone,* shows that the addition of a caustic alkali to a solution of a halogen considerably retards the rate of change which occurs on heating. An inspection of the results in these tables further shows that the greatest retardation occurs with chlorine, and the least with iodine; probably because the chlorine had the largest amount of molecular motion to be retarded.

In all these cases which are thus discussed by Dr. Gore, the leading idea is *the degree of freedom of molecular motion*, and the most general conclusion that can be deduced from a careful consideration of them is, that the *smaller* the degree of freedom of such motion of the halogen molecules, the *greater* the retardation of chemical change; heat therefore *increases*, and the presence of dissolved alkalies, salts, or acids *decreases* the rate of change, and retards the attainment of a fixed state of chemical equilibrium.

* *Proc. Birm. Phil. Soc.*, vol. vii., p. 47.
† *E.g., vide Phil Mag.*, January, 1892, p. 28.

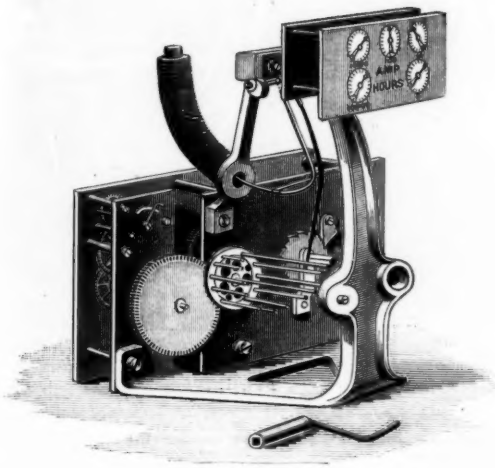
A PRACTICAL ELECTRIC METER.†

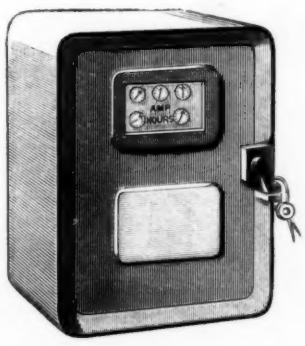
Registering meters are in one respect like an arc lamp, any electrician can devise a new one; it is a question only of how reliable, accurate and substantial it is, as also what its qualities are regarding cheapness and facility of reading. To devise one having a number of these good qualities is a very difficult matter. The Edison meter, for instance, used perhaps more than any other, is acknowledged by those who use it to be an excellent meter as regards reliability, but it has inherent objections, among the chief of which are the following: That it must be taken from the consumer's house to the office to be read, which involves much work and much loss of time; bills can therefore not be made out for all the consumers for the first of each month; it reads wrong if the current be accidentally reversed, which not infrequently happens in the Edison three-wire system; furthermore, the consumer cannot read the meter himself on dials, which has been found to be a great objection.

* *Phil. Mag.* January, 1892, p. 49.
† New York *Electrical World.*

It is to overcome these objections that Mr. Pilkington has devised the interesting little meter shown in the cut, which is now replacing the Edison meter in the Brooklyn plant. The general principle of this meter is that the positions of the pointer of the ampèremeter are recorded at regular intervals by a clock mechanism, and are summed up in a recording gear on which the readings are indicated on dials precisely like those of the gas meter, only that they read in ampère hours.

The ampèremeter itself consists of a curved solenoid having a light, movable, soft iron core swinging in a vertical plane. Attached to this pointer is a bent lever pivoted at





about its middle point on the pointer itself, and capable of rocking in a plane perpendicular to that of the pointer. It therefore follows the pointer but can move sideways. The little wheel shown, having 10 curved pins on it of different lengths, is driven by a 40-day clock which revolves it at a speed of five revolutions per hour. The rocking lever attached to the pointer is just long enough to engage with the wires on this wheel and will be moved through a definite amount by each one of these as they pass under it. As the deflection of the ampèremeter pointer is greater or less, there will be a larger or smaller number of pins which will engage with it. For a very small deflection, for instance, the lever will be moved by only one pin—the longest one—and for larger deflections it will be moved by a greater number of them. The length of each pin corresponds to an increase of deflection of half an ampère in the pointer, in a 10-light (five ampère) meter. As this current corresponds to one lamp, the meter will read accurately to within one lamp. If, for instance, five lamps are burning, five pins will engage successively with the lever and move it five times; each time it moves its other end drives a ratchet wheel ahead by one tooth, which wheel in turn drives the recording dials. The dials read to 99,999 ampère hours, after which they begin again at zero, as in the case of gas meters. The construction is precisely the same for larger meters, excepting only the ampèremeter and the value of the reading on the dials. The number of pins may also be made larger up to a certain extent, beyond which each pin will correspond to two or more lamps.

It will be seen that it is very simple in construction and contains no delicate mechanism; it requires merely to be placed on a level. It is one of the most satisfactory of its kind that has come to our notice. Neither a short circuit in the mains nor moderately rough handling will injure it. It is made by the Electric Construction and Supply Company, 18, Cortlandt Street, New York City, and is the joint invention of Messrs. Pilkington and White.

PROF. OSTWALD ON RECENT ADVANCES IN PHYSICAL CHEMISTRY.

AN address delivered by Prof. W. Ostwald, Ph.D., of Leipzig, before the United Sections of Physics and Chemistry at the yearly meeting of "The German Men of Science and Physicians" at Halle a short time ago, was more than usually interesting, on account of the numerous advances in physical chemistry which had to be noticed. In his account of these advances, the professor gave due prominence to the researches which have been in progress in that department of our science which is often termed electro-chemistry. All these have probably been noticed more or less in the ELECTRICAL REVIEW, but it is instructive to see from what point of view they are regarded by that school of workers in Germany of which Prof. Ostwald is so characteristic a type.

Referring to the connection between the different properties of substances, the professor said a fruitful line of thought has been carried out by Philippe-Guye. As is known, Maxwell had derived a definite relation between the coefficient of refraction and the dielectric constant, from his wide-reaching speculative investigations, which latter had yielded a complete analogy of the mathematical expressions for electro-dynamical and optical action at a distance, together with an approximate equality of the fundamental constants, and which have been finally made fruitful by the brilliant experimental investigations of Hertz. This dielectric constant is in turn, according to an expression due to Clausius, a simple function of that fraction of the total volume of a dielectric which is occupied by the actual material substance (considered as conducting). But this so-called true molecular volume is, finally, nothing but the co-volume in the equation of Van der Waals. There is accordingly to be expected a close connection between the critical constants and molecular refraction, and Guye has shown that the expected connection actually exists.

By referring to the empirical researches of Raoult and the labours of Van't Hoff, the professor paved the way to his introduction of Arrhenius's theory of electrolytic dissociation. It is certainly to be presumed that the fundamental idea of this theory is generally known. Readers of the ELECTRICAL REVIEW will remember that we have consistently followed them up, and have illustrated the views of both supporters and opponents of this hypothesis.

In the aqueous solutions of the electrolytes, the salts, acids, and bases, a greater or less proportion of the dissolved molecules are regarded as split up into electrically-charged constituents or ions, which exist in the solution independently of one another, in the same manner as the partial molecules of a dissociated gas. If the Vant't Hoff theory be admitted, said Prof. Ostwald, it must be admitted that in a solution of sodium chloride, for example, almost double as many individual particles or molecules are present, as in a corresponding

solution of sugar or urea of the same formula weight. The experimental connection of these variations with the fact, and numerical amount of the electrical conductivity, first discovered by Arrhenius, furnishes the basis for the second part of his theory, viz., the assumption of electric charges upon the separated molecular constituents or ions. He argued, therefore, that if these fundamental ideas are accredited, the remainder follow with directly evident necessity.

The professor then proceeded to treat this question from a general standpoint. He said: Let it be first called to mind that the laws of dissociation were already earlier derived thermo-dynamically for gases. If, then, in the field covered by Arrhenius, the question be one of dissociation, and the laws of gases do, according to Van't Hoff, hold for dissolved substances, it follows that the entire theory of the chemical affinity of electrolytes must be yielded by the application of those laws of dissociation. This means nothing less than that the problem of chemical affinity is in reality solved.

The general theory of the conditions whereby heterogeneous substances or heterogeneous phases of the same substance have assumed, after reciprocal influence, a condition of equilibrium independent of the time, has been developed by J. Willard Gibbs 16 years ago. Through Van't Hoff and Arrhenius, we are, according to Prof. Ostwald, now placed in a position to insert in the equations of Gibbs, which contain necessarily a great many of yet unknown functions, the expressions for these functions, together with the numerical constants, and to thus solve the problem numerically from case to case.

The professor was very enthusiastic over the possibilities of the Van't Hoff-Arrhenius theory. The dissociation, he said, discovered by Arrhenius, is an *electrolytic* one; accordingly, the immense number of phenomena in which the electrically charged ions participate belong likewise with those which here receive a new light. The questions as to the source and maintenance of the electrical energy in the galvanic elements, as to the conduction of current in electrolytes, as to the meaning of galvanic polarisation, are only single points in the vast field covered by this theory. Electro-chemistry in the widest sense, and, indeed, as much so that part which is concerned with essentially electrical questions as that which studies chemical questions, has already received most valuable furtherance from the theory, and has yet more in prospect.

Prof. Ostwald paid a very high tribute to the value of the Van't Hoff-Arrhenius theory as an aid to scientific investigation. He said, "No scientific idea produced in my time has assisted me in such measure as has this one."

Bromley Electric Lighting.—The clerk to the Bromley Local Board has been instructed to enter into negotiations for the purchase of land for an electric lighting station.

ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS AND TRANSFORMERS.

By RANKIN KENNEDY.

(*Continued from page* 508.)

FIG. 1 is a common type of alternator selected for the purpose of showing how simply an ordinary dynamo alternator may be converted into a generator of two currents alternating in quadrature phase difference.

It will be seen on reference to this fig. 1, that the coils on the armature are spaced out wide; this is necessary when one alternating current is to be generated; in the position

FIG. 1.

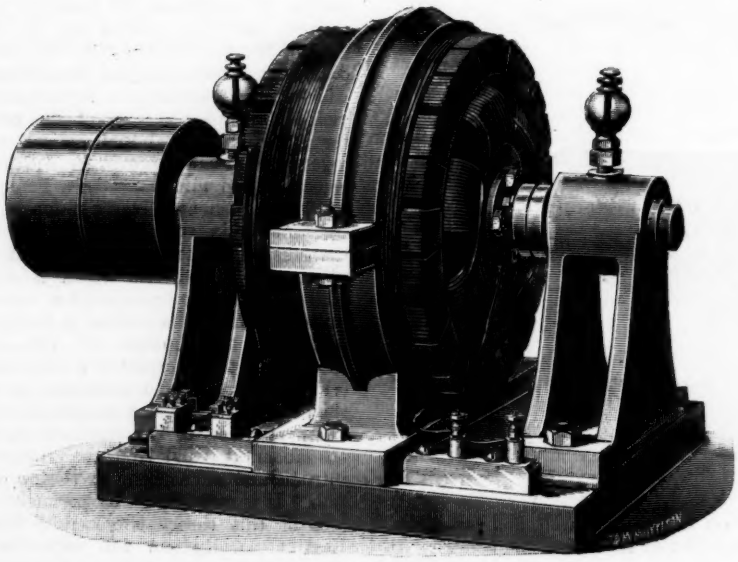


FIG. 2.

shown in the figure the coils are exactly between the poles, the induction through the coils is at its maximum rate of change, and therefore the E.M.F. curve would be at its maximum in this position of the coils. Now, if we wind in another series of coils between these shown, this second series of coils would be in a position of minimum rate of change of induction, and the E.M.F. curve in this second series would be at zero; that is, in other words, the current in the series of coils between the poles would be at its maxi-

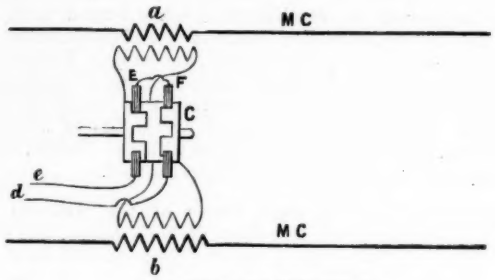
mum at the same instant that the current in the series of coils entirely clear of the poles would be at zero, that is, in quadrature with each other.

Fig. 2 represents one of the author's quadrature alternators. In this machine the armature is a fixture, and embraces a revolving field magnet, having six outwardly radiating poles alternately N. S. There are twelve coils on the armature connected in two series of six each, and thus the one series is always in quadrature with the other; when one series is just over the poles the other is exactly between them, and thus two currents in quadrature phase are generated.

These generators are made to generate the two currents at high pressure if the station is not situated in a district where a demand for current exists; but if the generating station is in a district where a large demand for current exists, then the alternators are preferably of low pressure, so that the low pressure may be supplied direct to the immediately surrounding district, and the distant districts are supplied through step-up transformers.

There is no difficulty about generating two alternating currents in quadrature phase; machines built for two currents in quadrature generally give nearly double the output of that built for single alternating currents. Quadrature alternators are perfectly self-regulating, being compound wound easily, the series current being derived from the two quadrature currents is practically continuous.

Fig. 3 is a diagram of the compounding arrangement, the two main currents are passed through two transformers *a* and *b*, and generate secondary currents proportional to the primary current; these secondary currents are rectified by



, Commutator; M C, Main current.

FIG 3.

the commutator, and put in series by the brushes *d*, *e*, E, F, and from them pass round the compound winding on the magnets.

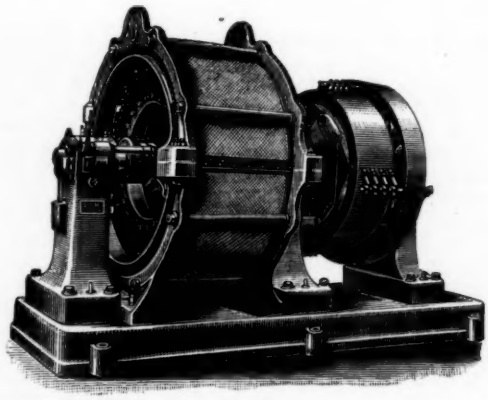


FIG. 4.

We may here describe the motor generator before mentioned as a machine for converting the simple alternating current into a continuous current. Fig. 4 represents one form, which has already been illustrated and shortly described by Mr. Esson in this Journal, page 402, October 2nd, 1891; the figure is reproduced here; the larger machine is the alternator motor, the small one the continuous current generator.

These machines are worked in connection with accumulators, so that they are usually started up to synchronous speed by a continuous current working the continuous current generator as a motor until this speed is attained, when the alternating current is switched on to work the alternator.

This arrangement demands the employment of two powerful machines, and the economy of the method must be low. It is, however, the only means of converting the simple alternating current into a continuous current.

(To be continued.)

NOTES.

Deptford Mains Nearly Completed.—The manager of the London Electric Supply Corporation has informed the Greenwich District Board of Works that in the course of a few weeks the laying of the mains in the Deptford division will be completed.

The Electric Light at Bordeaux.—The Chamber of Commerce at Bordeaux, France, have decided to light the principal quays with the electric light, and have asked the Compagnie de l'Eclairage Electrique de Bordeaux to send in a proposal to undertake the contract.

Electric Traction in Italy.—A second project for the construction of an electric tramway between Naples and Alfredena (Abruzzi) has been drawn up by Signor O. de Martino and Signor Ludovico Ghirelli, engineers, and has received the approval of the provincial technical department. It is proposed to operate the tramway by means of overhead conductors.

The Electric Light in France.—The town of Narbonne is to be lighted electrically. Tenders are being invited for the electric lighting of the small town of Divonne-les-Bains. The town of Gex is to be lighted electrically, a Swiss firm having secured the contract for the work. It is proposed to light the town of Romans electrically. A central station is proposed for the town of Dieppe. The town of Vire is to be lighted electrically.

The Electric Light in Germany.—A commission has recently been deliberating on the question of the introduction of the electric light in the German Reichstag buildings. The Bürgerliches Bran-Haus, at Pilsen, which is said to be the largest brewery on the Continent, is about to be installed with the electric light. The work will be carried out by the Deutschen Electrizitatswerken, of Aix la Chapelle, through their Pilsen agents.

The World's Fair Lighting.—Our New York contemporary the *Electrical Engineer*, comments strongly regarding the lack of knowledge as to the costs of electric light and power, which is so sadly displayed by the management of the World's Fair. Their ideas as to the cost of electrical plant seem to be absolutely *nil*, hence they "were talking about thousands of horse-power and hundreds of thousands of lamps in a way that was utterly absurd." The *Cincinnati Enquirer* says that when the bids were first opened, that of the Edison Company was $18.50 for each incandescent lamp for the entire time of the Fair, which for 93,044 lamps would have amounted to a total cost for lighting of $1,721,314. Some prudent advisers, however, pointed out that the figures were very exorbitant and the managers having reserved in their specifications the right to reject any and all bids, availed themselves of that right. The result is that the $18.50 bid has been shaved down to $5.95 and finally accepted. Instead of paying $1,721,314 for illumination, as the Edison Company first proposed the managers of the exhibition should pay, their total bill for illumination will now amount to $553,409.80, a saving of more than 66⅔ per cent. The *Electrical Engineer* thinks that "such an enormous reduction can only be interpreted by the public to mean either that a tremendous profit was sought for in the first instance or else that the work has now been taken at a terrible loss to keep out competitors. Both aspects of the case give a bad impression."

Omnibus Lighting in Berlin.—Trials are at present being made as regards the electric lighting of the omnibuses running in Berlin.

Western Counties and South Wales Telephone Company.—The Telephone Exchange at Exeter, was last week connected with the trunk line to Newton, Torquay, and Plymouth. The connection between Exeter and South Devon has been long promised, and it will prove none the less welcome for that reason. At the opening of the line, press representatives spoke with Newton Abbot, Torquay, and Plymouth, at each of which towns there is an exchange. In each instance the experiment was an unqualified success, every syllable uttered at the other end being clearly distinguishable. Mr. J. A. Bonathan, superintendent for Exeter of the Western Counties and South Wales Telephone Company and his assistants at the Exeter Exchange, bid fair to have increased duties imposed upon them now that Exeter is in communication with all the important South Devon towns, save Teignmouth and Dawlish, which have yet to be "switched on." The following places are now in telephonic communication with Exeter:—Newton, Torquay, Paignton, Brixham, Dartmouth, Totnes, Buckfastleigh, Ashburton, Plympton, Plymouth, and Rame Head.

Oil Insulation and its Ways.—Professor E. Thomson, says *Industries*, finds that the sparking distance is less for high-frequency pressures. There has always been a doubt about high-frequency pressures, as they are not generally measured. Most people assume that if they use a transformer wound a hundred to one they get a hundred times the pressure. In the first place there is a broken arc in the primary circuit, and if the high frequency transformer is in series with it, the pressure on the primary may be much less than that on the arc and primary together. Next a transformer's ratio of transformation is affected enormously by high frequencies. There is, therefore, so far, no reason to suppose the sparking distances are less for high than for low frequencies. Prof. Thomson also finds the time element important. Faraday's chains of conducting particles naturally take time to arrange themselves, especially in a viscid oil, so that very likely the correct explanation is that suggested by Professor Thomson. As our contemporary suggested recently, the whole subject wants thorough investigation. It is certainly in the very best hands when it is in those of Professor Elihu Thomson.

Varying Properties of Oil as an Insulator.—Regarding Prof. Elihu Thomson's article on "Experiments on high tension discharges of high frequencies (see Electrical Review, page 493) the author has written to the New York *Electrical Engineer*, as follows:—"It is more than probable that I shall have to make a revision of my views as stated in relation to oil as an insulator. In conducting my experiments I have been testing the striking distance in oil with varying periodicities and with varying forms of discharge electrodes, and I find that the results would seem to indicate that with an oil such as we have been using for the insulation of the high-period discharges at enormously high voltages, there is a much less resistance to discharges of the ordinary alternating character at low rates, such as 125 periods, or 250 alternations. I find that considerable distances in oil are punctured. In fact, the distances in some cases are quite comparable with the distance which the discharge leaps in air. I find, also, that with high-period currents, such as I get from my high-period alternating machine giving from 3,000 to 5,000 or more alternations per second, different effects are obtained; though the experiments are not yet complete. One of the most curious things noticed in the conduct of the experiments has been the time which it takes to break down the oil. For example, for a short contact of a half second or so, oil even in fairly thin layers seems to insulate, but if the contact be continued over some seconds, or even to half a minute or more, the discharge may break through the insulating layer. The time taken seems to increase with the distance of the electrodes apart under the oil. I have given these preliminary results hoping to investigate the subject pretty thoroughly and to really understand something about oil as an insulator before we get through."

Electrical Power in Italy.—Messrs. Schuckert & Co., of Nuremburg, Germany, have recently supplied a 30 H.P. electric motor to a flour mill in Rome, where it will be employed in driving a portion of the machinery.

Prize Competition.—The Berlin Society of Industrial Studies is offering a commemorative gold medal for the best essay on the magnetism of iron. The competitive essays may be sent in till November 15th, 1893.

Crystal Palace District Electric Lighting Company.—The Lewisham Guardians have assessed the property of the Crystal Palace District Electric Lighting Company at £500 provisionally.

York Corporation and Electric Lighting.—The Town Clerk of York has issued a circular stating that a proposal will shortly be submitted to the City Council that they shall exercise at an early date powers which the corporation have obtained for lighting the city by electricity. The object of the circular will be to ascertain how many of the inhabitants would become consumers of the electric light.

The American Institute of Electrical Engineers.—According to the *Electrical World*, the general meeting of the above institute will be held in Chicago this year, the date fixed upon being June 6th and 7th. The Western meeting will, it is hoped, result in the acquisition of many new members, as at present there are not very many representatives from that section of the country.

Philosophical Society of Glasgow.—Mr. William Aitken, engineer to the National Telephone Company, Limited, South of Scotland District, delivered a highly interesting and instructive lecture on the 27th ult. before the Philosophical Society of Glasgow, the subject being "The new pattern of switchboard about to be installed in the new Glasgow switch room." The meeting was largely attended, and its interest greatly enhanced by the aid of about 50 receivers, which were in connection with the theatre, where the opera of "Carmen" was being performed.

Counter Electromotive Force of the Arc.—It has usually been supposed, says New York *Electricity*, that there existed in the electric arc a counter electromotive force, but Fr. Stengen, in *Wiedeman's Annalen*, thinks it a mistake. He thinks it possesses merely resistance, in proof of which he states that if a tangent galvanometer, sufficiently delicate to indicate a very small electromotive force, be placed between the terminals of an arc lamp, and the latter be extinguished, it should show a reverse kick in the needle, whereas the fact is that as the arc dies down, the needle merely returns to zero, which would be the case if there were nothing but resistance concerned.

Technical Journalism.—The April issue of the *Manufacturers' Engineering and Export Journal* is quite of a special nature, the main feature of its contents being the most complete description ever published of the famous electrical works of Messrs. Siemens Brothers at Charlton. The illustrations include some 30 beautiful process blocks, besides a large number of woodcuts of the company's smaller manufactures. Amongst the former are excellent portraits of the late Sir William Siemens, Dr. Werner von Siemens, and Carl Siemens; many fine views of the buildings and workshops, core and cable testing rooms, cable tanks, dynamo fitting and instrument shops, the cable steamer *Faraday* from five different points, and a double-page engraving, an exquisite specimen of the photo-engravers art, of the main dynamo shop. The article commences with a short biographical notice, and, after dealing with the formation of the company, gives particulars of some of the more important contracts carried out. The works are next described, and the review concludes with brief descriptions of some of the company's manufactures. Altogether, illustrations and letter-press comprise no less than 39 pages, and, with the addition of other matter of a miscellaneous kind, the number is a capital example of enterprise in technical journalism, and forms a pleasing *souvenir* of the immense edifice which has sprung from the advent of Charles William Siemens into England 49 years ago. We understand that the works of other well-known firms are to be similarly treated.

The Electric Light at Loughborough.—On Saturday evening the first attempt at using the electric light for the purpose of shop illumination at Loughborough was made by Messrs. Walter Claypoole and Son, and was a marked success.

Eastbourne and the Electric Light.—Several members of the Eastbourne Corporation availed themselves of an invitation from the managing director of the Electrical Exhibition at the Crystal Palace to visit the exhibition on Wednesday, last week.

The Institution of Electrical Engineers.—On Thursday, May 12th, 1892, there will be a continuation of discussion on Mr. A. P. Trotter's paper, "Notes on the Light of the Electric Arc," and a paper "On the cause of the changes of Electromotive Force in Secondary Batteries," by Dr. J. H. Gladstone, F.R.S., Member, and W. Hibbert, Associate.

Personal.—Mr. R. J. Elmhirst, who retired from his post as electrician in the P. & O. Company's service a few weeks ago, has been appointed electrician to Dan Rylands, Esq., to take charge of his coal mine and glass factory installations near Barnsley. Mr. Elmhirst qualified himself in the electrical engineering works of Ronald A. Scott, M.I.E.E., Acton Hill, W.

Explosion at Preston.—It is stated that the other morning an extraordinary explosion took place in Lancaster Road, Preston, on one of the mains which the National Electric Supply Company have laid down for conveying power to their customers. At the time stated a young man took a lighted candle to examine the main, and an explosion occurred. The young man only had his face singed, but the main was injured and the parapet was raised about a foot in height for a distance of nearly 20 yards.

The Electric Lighting of Halifax.—The Board of Trade have decided to grant to the Corporation of Halifax a provisional order for the electric lighting of the area comprised within the county borough.

Electric Lighting in Aberdeen.—A sub-committee of the Gas Committe of the Aberdeen Town Council have recommended that Prof. A. B. W. Kennedy, of the Westminster Electric Lighting Corporation, London, should be requested to visit Aberdeen and report to the Town Council as to the best mode of dealing with the question of electric lighting, giving full information as to the cost, system of supply, mode of distribution, and other details.

Taunton and the Electric Light.—For the consideration of the proposed purchase by the town of the Taunton Electric Light Work, a special meeting of the Taunton Town Council was held last Tuesday. The report of an expert—Mr. Gisbert Kapp, of Westminster—who had been appointed to examine the works, was presented. The special point on which the expert was to express his opinion was whether the works were worth the £10,000 which it was proposed to give for them. Mr. Kapp said the present system in Taunton (the Thomson-Houston) was not suitable for small areas, and could not be worked at a profit if the supply must be continuous. For that reason he could not advise the council to buy the works as a going concern. If the council determined to start an entirely new station, they could take over several things from the existing company, for which they should pay £5,250. The total cost of a complete works, suitable for the supply of 2,000 16-candle-power private glow lamps, and 44 street arc lamps, would be £15,900. The annual working expenses would amount to £2,660, including payment of loan, and the annual revenue would amount to £2,900. On the strength of this report, the committee which has the matter in hand, recommended the council not to purchase for £10,000, and the Mayor, in moving the adoption of the report, spoke of the excellence of the electric light in Taunton, and said it was not proposed to abandon negotiations for the purchase. They could not afford to let the light go out at Taunton. It was decided to defer the matter until the next council meeting, for enquiries to be made as to the successful working of the Thomson-Houston system in other places, and whether Mr. Kapp was interested in any other system of electric lighting.

The Royal Society.—The following paper was down for reading last night:—"On the Simultaneity of Magnetic Variations at Different Places on Occasions of Magnetic Disturbance, and on the Relation between Magnetic and Earth Current Phenomena," by W. Ellis.

Derby and the Electric Light.—At the meeting of the Derby Town Council on Wednesday a recommendation was made for the Corporation to undertake the lighting of the central part of the town, both public and private property, with electricity, and £30,000 will be asked for to defray the cost of the installation, with engines, dynamos, underground mains, &c.

The Electric Lighting of Bristol—Tenders Accepted.—At the meeting of the Electrical Committee of the Bristol Town Council last week, Mr. Preece presented his report on the tenders for the supply of dynamos and boilers, which had been referred to him for the purpose of ascertaining that the specifications had been observed. In four cases Mr. Preece found that they had not been complied with; but there were still a dozen tenders for dynamos and eight or ten for boilers. The former ranged from £14,000 odd to about £20,000, and the latter from £7,450 to nearly £10,000. In each instance the three or four lowest tenders were remarkably close together. It was decided to accept the tender of Messrs. Siemens Brothers & Co., of London, for the supply of dynamos for £14,011, and that of Messrs. Tinker Brothers, of Hull, for the boilers at £7,450.

The London Telephone Service.—The Committee of the Association for the Protection of Telephone Subscribers have issued a circular in which they state that in the absence of any prospect of improvement in the service of the National Telephone Company, they have entered into negotiations with the New Telephone Company, resulting in an agreement whereby the members of the association (up to the number of 3,000) are to be given by the new company the use of a telephone free of charge for the currency of their year's subscription to the National Company, and subsequently on rental at a reduced rate. It is not quite clear whether, when their contract is carried out, the Association will have completed its functions, or whether it will continue to protect the interests of telephone subscribers regardless of the company to which they may subscribe.

Royal Society Conversazione.—At the annual *conversazione* of the Royal Society on Wednesday evening many interesting exhibits and experiments of an electrical nature were shown, including a demonstration by Prof. Crookes of the Tesla experiments. Messrs. Pyke and Harris also showed high tension apparatus, and Prof. Oliver Lodge illustrated the behaviour of the electric spark in and to water, and the different effects of a positive and a negative discharge. A spark to water spreads out on the surface in a crow-foot pattern, showing, apparently, that the surface layer is a feeble dielectric. A spark under water is short and very violent, treating the water as a dielectric and producing concussion. Mr. Wimshurst was also present with some wire-coated Leyden jars, the terminals of which exhibited certain interesting inductive phenomena. Captain Holden, R.N., exhibited several testing and measuring instruments, and a high-speed chronographic pen for taking a number of successive records of short intervals of time on a revolving drum, and an electric chronograph was exhibited by Rev. Frederick J. Smith, designed for measuring the velocity of projectiles. Amongst the non-electrical novelties, probably the most generally interesting and the most important was the process of composite heliochromy, by which a photograph is produced in natural colours. This was shown by the inventor, Mr. Frederick E. Ives, of Philadelphia.

The Electric Light at Bath.—A report from the electric light inspector has been under discussion at a meeting of the Bath Town Council, and disappointment with the light was expressed by a member. It was stated, however, that the cause of the difficulty had been the globes, and that the latter would be replaced by the Pearline shades as they were required. An opinion was expressed that the company should put up the new globes at once, as the light admittedly was less than contracted for. It was decided that the company should be asked to replace the present unsatisfactory globes.

Fatal Accident.—The *Times* states that on Wednesday an accident of a shocking nature, resulting in the death of William Pemberton Bannister, happened at Glass Houghton Colliery, Castleford. Bannister, who was an electrical engineer, about 22 years of age, was experimenting with the manager with a coal-cutting machine. Immediately after the motive power had been put on Bannister called out, "Oh! my foot is fast." On the manager shutting off the electrical power and going to the assistance of Bannister, he was horrified to find that his left leg had been dragged completely off by the coal-cutter, and that the other leg had been severely crushed. The injured man was removed to Leeds Infirmary, where he expired shortly afterwards. He had been sent specially from London to conduct the experiment.

International Horticultural Exhibition.—What bids fair to be a most interesting and attractive exhibition is to be opened to-morrow (May 7th) at Earl's Court by the Duke and Duchess of Connaught. It is intended to illustrate the various phases of the Horticultural Arts, and to bring together in one grand display not only the representative styles of different countries as they exist to-day, but reproductions of English and foreign gardens of former periods. Buffalo Bill (Col. Cody) has returned to London, and is to give his display of the wild life of the West, having brought with him from America many more Indians than before, including some who took part in the last war with the Redskins. The electric lighting is to be on a larger scale than on any former occasion, the contracting electrical engineer being Mr. A. H. Wood, of 39, Victoria Street, who is fitting up in the buildings and grounds 210 10-ampère series lamps (Brush), and in the Wild West arena 11 40-ampère parallel projectors. The last have a special self-regulating apparatus, which is somewhat of a novelty, and calculated to diffuse a more equal light than in former years over the vast circus. Eight series machines (Brush) will be used for the arc lighting, and two 250 ampère 65-volt machines for the projectors. There will also be some 600 incandescent lamps about the buildings fed by Mordey alternators and transformers. The engines are three of Davey Paxman & Co.'s make, one 70 nominal H.P. and two 40 H.P., with loco. multitubular boilers, running countershafting divided into three sections to meet any emergency or breakdown. The centre fountain will be an attractive item, the coloured incandescent lamps of which will be controlled by an automatic switching arrangement actuated by a water wheel, the whole of which has been specially designed by Mr. Wood. The installation has been carried out at very short notice, the order having been given only five weeks back; the former contractors having removed the whole of the wiring and plant has necessitated the buildings and grounds being entirely re-installed and plant erected.

Electric Lighting Acts.—Mr. Courtenay Boyle has sent us a copy of the Fourth Schedule to Provisional Orders under the Electric Lighting Acts, and he specially calls attention to the new name which has been given to the unit of supply by the Board of Trade. In this schedule the expression "kelvin" shall mean the energy contained in a current of 1,000 ampères flowing under an electromotive force of one volt during one hour. 1. Where the undertakers charge any consumer by the actual amount of energy supplied to him, they shall be entitled to charge him at the following rates per quarter:—For any amount up to 20 kelvins, 13s. 4d.; and for each kelvin over 20 kelvins, 8d. 2. Where the undertakers charge any consumer by the electrical quantity contained in the supply given to him, they shall be entitled to charge him according to the rates set forth in section 1 of this schedule, the amount of energy supplied to him being taken to be the product of such electrical quantity and the declared pressure at the consumer's terminals, that is to say, such a constant pressure at those terminals as may be declared by the undertakers under any regulations made under this order.

When is this absurd fashion of rechristening likely to cease? The Board of Trade unit is perfectly well understood under its present appellation, and we do not consider its new name complimentary either to Sir William Thomson, or redounding to the good sense of those who have forced it upon the public.

NEW COMPANY REGISTERED.

Western Counties Electric Light and Power Syndicate, Limited.—Capital, £25,000 in £50 shares (380 ordinary and 120 deferred). Objects: to enter into an agreement dated April 22nd, 1892, between G. J. and G. J. T. J. Parfitt of the one part and S. F. Andrews (for the company) of the other part, for the acquisition of the business of electrical engineers carried on by Messrs. George Parfitt and Son at Keynsham, Somerset; and to carry on the business of electrical and mechanical engineers, suppliers of electricity, &c. Signatories, J. H. Clifton (5 shares); H. R. Wansbrough (5); H. A. H. Daniel (5); J. C. Gilmore (2), and J. B. Bond (5), all of Bristol, and G. Wilton (2) and C. Harrison (5), of Keynsham. The number of directors is not to be less than three nor more than seven, the first being H. A. H. Daniel, H. R. Wansbrough, and F. B. Bond. Qualification, five shares. Remuneration as the company in general meeting determines. Registered on the 26th ult by Jordan and Sons, 120, Chancery Lane, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Wynne's Electric Closed-Tube Tramways, Limited.—The annual return of the above-named company made up to March 12th, 1889, was filed on the 4th ult. The nominal capital is £6,000 in £100 shares, of which 47 had been taken up. Of these 32 had been issued as fully paid, while upon the remainder the full amount had been called, and £1,430 had been paid, leaving £70 unpaid. Another return, made up to September 1st, 1891, and filed on the 25th ult., shows exactly the same result as the preceding. The last return, made up to the 12th ult., was filed on the 25th ult., when 52 shares had been taken up, and 32 issued as fully paid. Upon 15 shares the full amount had been called, while upon 5 shares £75 per share had been called, resulting in the payment of £1,805, and leaving £70 unpaid. Registered office, 5, Westminster Chambers, Victoria Street, S.W.

Notting Hill Electric Lighting Company, Limited.—The annual return of this company, made up to the 14th ult., was filed on the 28th ult. The nominal capital is £100,000, divided into 9,450 ordinary and 550 founders shares of £10 each. Of these 6,452 ordinary and all the founders shares have been taken up, the full amounts called and all calls (£70,020) paid. Registered office, 9, Austin Friars, E.C.

National Telegraph Works Company, Limited.—The following notice was filed on March 15th, 1892. At an extraordinary general meeting of the above-named company, duly convened and held at the registered office of the company, on Friday, February 19th, 1892, the subjoined special resolution was duly passed, and at a subsequent extraordinary general meeting of the said company, also duly convened and held at 34, Waterloo Street, Birmingham, on March 9th, 1892, the said subjoined special resolution was duly confirmed:—"That the company be wound up in voluntary liquidation, and that Mr. James Rhodes, chartered accountant, 34, Waterloo Street, Birmingham, be and is hereby appointed liquidator." Registered office, 109, Wainwright Street, Aston, near Birmingham.

Pontypridd Electric Lighting Company, Limited.—The annual return of this company, made up to March 28th, 1892, was filed on the 23rd ult. The nominal capital is £10,000 in £5 shares, of which only seven have been taken up, and no calls have been made. Registered office, 40, Mill Street, Pontypridd, Glamorgan.

Birmingham Electric Supply Company, Limited.—The annual return of this company, made up to March 3rd, 1892, was filed on the 26th ult. The nominal capital is £100,000, in £5 shares, of which 17,173 have been taken up. Upon 10,006 of these the full amounts have been called, while upon the remaining 7,167 shares £1 per share has been called. The calls received amount to £57,174 10s., and the calls as yet unpaid amount to £22 10s. Registered office, 14, Dale End, Birmingham.

Brush Electrical Engineering Company, Limited.—The annual return of this company, made up to October 5th, 1891, was filed on March 8th, 1892. The nominal capital is £750,000, divided into 150,000 preference shares of £2 each, and 150,000 ordinary shares of £3 each. 77,978 ordinary and 69,996 preference shares have been taken up, upon all of which the full amounts have been called. The calls paid amount to £373,923 10s., leaving £2 10s. unpaid. Registered office, Albert Buildings, 49, Queen Victoria Street, E.C.

House-to-House Electric Light Supply Company, Limited.—The annual return of this company, made up to the 19th ult., was filed on the 29th ult. The nominal capital is £350,000, divided into 57,900 ordinary, 12,000 preference, and 100 founder's shares of £5 each. At the time of making up the return 8,322 ordinary, 2,800 preference, and 100 founder's shares had been taken up, of which 1,000 of the ordinary and the founder's shares had been issued as fully paid. Upon the remaining shares the full amount had been called, and as a result £50,210 has been paid, with £400 as yet unpaid. The new registered office (filed on March 23rd) is situate at the Kensington Central Electric Lighting Station, Richmond Road, Earl's Court, London, S.W.

Electricity Supply Corporation, Limited.—At extraordinary general meetings of this company, held March 29th and April 13th, 1892, the following special resolutions were respectively passed and confirmed :—(1) That the capital be reduced by cancelling the 100 founders' shares of £10 each, which have not been taken, or agreed to be taken, by any person. (2) That each of the remaining £10 shares be divided into two £5 shares, upon each of which the amount to be credited as paid up shall bear the same proportion to the sum of £5 that the amount credited as paid up upon the whole share bears to £10. (3) This clause provides for the raising of the capital to £150,000 by the creation of 200 new shares of £5 each, and (4) Provides for several alterations in the articles of association.

Grange Syndicate, Limited. (Groth's Electric Tanning System).—Upon the petition of the firm of W. Moore, tanners and leather merchants, of 24, Richardson Street, Long Lane, Bermondsey, in the High Court of Justice, Chancery Division, on March 19th, 1892, Mr. Justice Stirling ordered that the company should be wound up, and appointed Mr. C. J. Stewart, official receiver, the provisional liquidator of the affairs of the company (filed on the 2nd ult.). Registered office, 56, Gray's Inn Road, London, W.C.

Hastings and St. Leonards-on-Sea Electric Light Company, Limited.—The annual return of this company, made up to February 9th, 1892, was filed on February 15th, 1892. The nominal capital is £50,000 in £10 shares, of which 843 shares have been taken up. The full amounts have been called, and, with the exception of £45, paid. Registered office, 20, South Terrace, Earl Street, Hastings.

Globe Electric Company, Limited.—The registered offices of this company have been removed to 6, Ropemaker Street, Finsbury Pavement, E.C.

Davis and Timmins, Limited.—The annual return of this company, made up to October 20th, 1891, was filed on March 11th last. The nominal capital of the company is £20,000 in £10 shares, of which 1,253 had been taken up, and of these 300 had been issued as fully paid. Upon the remaining 953 shares the full amounts have been called and paid. Registered office, 24, Charles Street, Hatton Garden, E.C.

PARLIAMENTARY NOTES.

ELECTRIC LIGHTING.

In the House of Commons on Thursday, April 28th., in reply to Mr. Bartley,

Sir M. HICKS-BEACH said: In cases where objection to an application for a licence or provisional order under the Electric Lighting Acts is made by any person locally interested, the Board of Trade do, if they consider it expedient, hold a local inquiry; but the circumstances of different applications vary so much that it is impossible to lay down any definite rule as to the grounds which would justify the holding of such an inquiry.

THE SIGNAL LIGHT OF THE HOUSE.

In the House of Commons last Monday, in answer to Mr. P. O'Brien,

Mr. PLUNKET said: The cost of the signal light of the House of Commons per Session, including the attendant's wages is £60. The initial cost of substituting an electric light, as suggested by the hon. member, would not be less than £750, and its annual cost £150. I believe, however, that it would be possible to re-arrange the existing gas signal light so that with the assistance of lenses it could be made visible all round, at an initial expense of, approximately, £400 or £500. I cannot undertake to carry out any change this Session, but I think there is substance in the complaint of the hon. member and I will take care that it is considered in connection with next year's estimates.

LEGAL.

Millward & Co. v. Crompton & Co., Limited.—The case of Millward & Co. *v.* Crompton & Co., which was decided on Thursday last week by Mr. Justice Cave, sitting without a jury, in the Queen's Bench Division, London, was an action by a firm of solicitors, practising at Birmingham, against Messrs. Crompton & Co., electrical engineers, of Chelmsford, to recover £691, money paid by plaintiffs to Parliamentary agents in respect of electric lighting provisional orders obtained on behalf of the Crompton-Winfield Association.

Plaintiffs paid away £941 16s. They had received on account £253 2s., and a balance remained due of £691 14s.—In defending the action the defendants admitted trading with Messrs. Winfield under the style of the Crompton-Winfield Association, on terms contained in an agreement by which all moneys payable by the association were to be paid by Messrs. Winfield & Co. Mr. Justice Cave, after hearing evidence, gave judgment for the plaintiffs for £691 14s. and costs.

BUSINESS NOTICES, &c.

The Electric Light in Manchester.—The directors of the Manchester Palace of Varieties have recently made some alteration in the arrangement of the electric lighting of the Palace, which was installed and operated by Messrs. Rashleigh Phipps and Dawson, Berners Street, W. This firm has now been bought out by the Palace Company for the sum of £5,000, part in cash, and part in debentures, and at the same time an agreement has been made for them to work the light for 12 months for £20 per week, including lamp breakages. As the electric lighting—including the installation and working—has hitherto cost the company £100 a week, it will be seen that an enormous saving has been effected, after 5 per cent. interest on the £5,000 is allowed for.

Tenders Wanted—Southampton.—Tenders are invited for the electric lighting of the Corporation Baths, Western Shore, for the Southampton Corporation. Specifications may be had, and plans may be seen and all further particulars may be obtained, upon application to Mr. J. G. W. Aldridge, electrical engineer, at 9, Victoria Street, Westminster, and at 23, High Street, Southampton. Sealed tenders, endorsed "Electric Lighting, Baths," must be left at the office of Mr. R. S. Pearce, town clerk, Municipal Offices, Southampton, by 2 p.m. on May 16th.

Tenders Wanted—Blackpool. — The Corporation of Blackpool are prepared to receive tenders for the right of user, for a period of 7 years, of certain electric tramways constructed and authorised under the Blackpool Corporation Tramways Order, 1884. Further information will be seen in our advertisement pages.

Tenders Wanted—Leeds.—The directors of the Yorkshire House-to-House Electricity Company are inviting tenders for the supply and erection of the necessary machinery, &c., for a central electricity supply station, and for providing and laying underground mains. Further particulars will be found in our advertisement pages.

Tenders Wanted—Liverpool.—The Liverpool Corporation invite tenders for the execution of certain electrical work, consisting of wires and instruments for telephonic communication, and other electrical appliances. For further particulars see our advertisement pages.

Colliery Electric Lighting.—The engine house, boilers, and pit bank, and a portion of the underground workings of the Black Park Colliery, Chirk, have recently been lighted by electricity. There are about 30 Swan lamps in use, ranging from 16 to 50 candle-power, and the machinery, we believe, is capable of lighting as many more. The whole plant was supplied by Messrs. Mercier & Corlett, electrical engineers, of Wigan and Bolton, and was erected under the management of Mr. Whittle.

The Electric Light in the Strand.—Messrs. Woodhouse & Rawson, of Queen Victoria Street, E.C., have completed an installation of the electric light on the premises of Messrs. Nurthen and Co., chemists, Strand.

Messrs. Laing, Wharton & Down, of New Bond Street, are fitting up an installation in the premises of Messrs. Short's wine stores, also in the Strand. This firm have also recently completed an installation at Messrs. Short's branch establishment in St. Paul's Churchyard.

Electric Lighting a Flour Mill at Bishop Auckland.—Messrs. Cox-Walkers have just completed an installation of the electric light for Messrs. Appleton, French and Scrafton, at their Stopford Roller Mills, Bishop Auckland, using one of Robey's high speed vertical engines, and a Royal dynamo. About 100 incandescent lamps are installed in the mill, and 50 others in Mr. Scrafton's residence, stables, &c., adjoining. The results are very satisfactory.

Country House Lighting.—Mr. Henry Simon has decided to instal the electric light throughout his new house which is being built at Didsbury. The current is to be obtained from two gas engines and two dynamos placed in an outhouse near the main building. The installation has been placed in the hands of Messrs. Drake and Gorham.

Electric Light in the Meat Market.—Messrs. J. Sax and Co. have secured the contract for lighting the London Central Market with electric incandescent lamps. Messrs. Sax will fit the plant without any cost on the part of the tenants, and the contract also imposes the free lighting of the market avenues for a period of 21 years.

London Electric Supply Corporation.—The London County Council have sanctioned the application of the London Electric Supply Corporation to lay on the electric light at the Ophthalmic Hospital at St. George's Circus.

New Address.—Mr. William E. Ommanney, electrical engineer, formerly of 1, St. George's Place, Gloucester Road, S.W., has removed to 185, Victoria Street, S.W.

CITY NOTES.

Submarine Cables Trust.

THE report of the trustees states that the revenue for the financial year, to April 15th, 1892, including the balance of £2,636 15s. 9d., brought from the previous accounts, amounted to 25,436 1s. 6d. During the past year the following coupons have been met: Due April 15th, 1891, £1 paid on account May 15th, 1891, and £2 paid balance October 15th, 1891; due October 15th, 1891, £3 paid March 15th, 1892; due April 15th, 1892, £1 2s. 6d. payable 16th April 1892. The expenses of the trust amounted to £1,186 15s. 9d., and the payments on account of the coupons to £24,089 12s. 6d., together £25,276 8s. 3d., leaving a balance of £159 13s. 3d. to be carried forward. A table showing the original and present investments of the trust is given. It remains unchanged since last year. Telegraph securities have maintained their value. It is with regret the trustees have to record the death of their secretary, Mr. Lewis Wells. They have appointed as his successor Mr. William Payton. The meeting will have to elect two auditors for the current year; Mr. John G. Griffiths and Mr. John Gane offer themselves for re-election.

The twenty-first ordinary annual meeting of the certificate holders of this trust was held yesterday at the offices of the company, Winchester House, Old Broad Street, E.C., Sir John Pender, K.C.M.G., in the chair.

The SECRETARY (Mr. Payton) having read the notice convening the meeting, also the minutes of the previous meeeting,

The CHAIRMAN gave a short statement of the position of the company—of its revenue during the last year. The revenue amounted to £22,799, as against £23,666 in 1891, showing a decrease of £867. In the previous year the trustees made a small profit of £264. Investments and the income derived from their investments in the Anglo-American stock was about £600 less than in 1891. The expenses for the year amounted to £1,186, as compared with £1,175, a small increase of £11. The trustees reminded the certificate holders that the cost of administering the trust was £813 under the amount provided by the trust deed. That was due in a great measure to the trustees not having filled up the vacancies which occurred by the death of two of their colleagues. The trustees thought that the time had come when those vacancies should be filled, and they thought it judicious to select two younger men. The names of the two gentlemen were Mr. John Denison Pender and Mr. K. Anderson. Their revenue during the past year had been sufficient to meet two bonds of £3 each, and pay off in addition 7s. of the overdue coupon. There remained still a balance of £1 17s. 6d. in arrears, which the income from the investments would obtain. They trusted that the arrears would be gradually paid off. They hoped to pay the balance of the coupon due on April 15th, on about August 1st next. He thought it right to state that a trust of that kind required people to be constantly in attendance, and in introducing young blood into it he thought it was the right thing to do, as some of them were getting old, and their attendance might not be so regular as they might themselves wish. The suggestion, therefore, had been made after considerable thought, and with the thorough belief that the young men appointed knew exactly the nature of the trust, and that they would also be in touch with the general public as to the value of the interests of the stocks represented. Mr. Anderson knew something of what was going on outside, and Mr. John Denison Pender knew perfectly well all that was going on inside. He did not think they could have elected two better men to fill the position. He then moved that the report and accounts of the trustees be received and adopted.

Sir JAMES ANDERSON seconded the motion, which was carried unanimously.

It was then formally proposed by the CHAIRMAN that Messrs. J. D. Pender and K. Anderson be elected trustees of the trust.

The MARQUIS of TWEEDDALE seconded the resolution, which was unanimously carried.

The auditors, Messrs. John G. Griffiths and John Gane, were re-elected, at a remuneration of £25 each.

A vote of thanks to the chairman closed the proceedings.

Great Northern Telegraph Company of Copenhagen.

THE report of the directors to December 31st, 1891, states that the receipts have amounted to £359,646, and the expenses to £65,448 leaving a net profit of £294,197. Five per cent. interest has been paid upon the debentures of the 1883 issue, the amount so paid being £11,250, while the amortisation of 100 debentures has absorbed £10,000. The balance of profit is distributed as follows:—Reserve and renewal fund, £83,333; pension fund, £2,777; directors' remuneration, £1,500; interim dividends, £75,000; final dividend of 17s. 2d. per £10 share, making a total dividend of about 8·60 per cent. for the year, £56,169; balance forward, £272,947. The reserve and renewal fund now amounts to £745,112.

At the annual general meeting held at Copenhagen on Saturday last, 30th ult., the chairman, Mr. C. F. TIETGEN, in rendering an account of the working of the company during the year 1891, referred to the company's cables, which, he said, had on the whole been working normally. Although the new concession granted by the French Government was not ratified until June last, the laying of the duplicate cable between France and Denmark had been successfully carried out during the latter half of July. This cable, which had been manufactured by the Telegraph Construction and Maintenance Company, Limited, of London, was about 370 nautical miles long, and the core and armature had been chosen with the special view of securing an electrically and mechanically perfect cable of the most solid description. The effect of the establishment of this duplicate line had already shown itself in the greater amount of traffic and in the increased regularity and speed of transmission. The anti-foreign riots, which had agitated the Chinese Empire during part of the year, had not interfered with the company's business in any way. In one of the interior provinces, however, the animosity of the rioters against the telegraph had vented itself in the destruction of thousands of telegraph poles, belonging to the Chinese Administration, and intended for the construction of an internal line. This occurrence was an additional proof of how indispensable submarine cables were in China, and how little foresight was displayed by those who agitated in favour of landlines to the detriment of the submarine connections. The traffic receipts had been most satisfactory during the first six months, in which they had even exceeded those of the corresponding period of the previous year. On July 1st, however, the tariff reductions fixed by the International Telegraph Conference at Paris came into force, and these had caused a marked falling off in the receipts for the rest of the year. Nevertheless, the total gross receipts were a little higher, while the expenses, thanks to the profits realised by the company's workshops and cable steamers, were somewhat lower than in 1890. Under the circumstances, the board of directors considered themselves justified in recommending that the total dividend be fixed at the same figure as last year, say, 17s. 2d per £10 share, or about 8·60 per cent.

Eastern Extension, Australasia and China Telegraph Company, Limited.

SIR JOHN PENDER presided over the general meeting held at Winchester House on Wednesday.

After the usual formalities, the CHAIRMAN went through the items of the report (published in the last issue of the REVIEW). The decrease of £35,407 was due mainly to fluctuations in exchange, to the reduced rates to Australia, and to the general commercial depression which had prevailed in eastern countries for some time past. Working expenses had been practically the same as 1890. The usual interim dividend had been distributed, making, with the dividend then proposed to be paid, a total of 5 per cent.; in addition, a bonus of 4s. per share would be paid, which would make the total distribution of 7 per cent. for the year. £111,987 had been carried to the reserve fund. Since 1873 they had spent in renewals and duplications over a million of money, and it was to this fact that the company owed its present proud position. Sir John then went on to speak about the reduced rates to Australia. Since the report had been issued to the shareholders they had completed another month's working under the guarantee arrangement made with certain Australian Governments for testing the effects of a four shilling rate to Australia. The number of words transmitted had increased 50 per cent. for the corresponding period of 1890-91, and 61½ per cent. over that of 1889. Receipts had diminished to the extent of £55,540. As they (the shareholders) were aware, half of this was borne by the guaranteeing colonies. As the directors never expected that the entire loss would be recouped in one year, they were not disappointed with this loss, and have consented to the experiment being carried on at least another year, His own opinion upon the subject was, that the increase in traffic was a remarkable one indeed, and he had no hesitation in considering it to be permanent. But at the same time they had to consult the Australian colonies. The advantages gained, however, by the colonies, were too great for them to go back to the old system. The company's repairing steamers had, as usual, been busily employed during the last half-year. Owing to the fact, however, that most of the cables were duplicated, traffic had not been materially affected. The exception was at Manila, where the cable between Hong Kong and Cape Bolinao was broken during a typhoon. Negotiations were proceeding with the Spanish Government for the duplication of the

cable between Hong Kong and Cape Bolinao. An arrangement had also been entered into for the manufacture and laying, on account of the Netherlands-Indian Government, of a cable to connect Acheen with the company's new line at Sumatra, and the Telegraph Construction and Maintenance Company's steamer *Seine* would this week leave the Thames with the requisite cable on board to execute this work. As to the staff pension fund, the directors had had a scheme prepared by experienced actuaries, who had advised that an annual contribution of 2½ per cent. on the salaries and a similar contribution by the staff would, if invested at 4 per cent. compound interest, provide sufficient funds to make adequate retiring allowances for the younger members of the staff on their attaining 60 years of age, but as many of the older *employés* had already seen considerable service, and their retirement in some cases could not be far distant, 2½ per cent. would be insufficient to place them on an equally favourable footing. With a view, therefore, to supplementing their allowances from the pension fund, the actuaries advised that, in addition to the 2½ per cent. referred to, the company should continue their present contribution to the endowment assurance fund in full until all the existing policies were paid off, and allow the savings effected by the premiums ceasing to be payable to the assurance company as the policies matured from time to time to be applied exclusively for the benefit of the older servants. They further recommended that the company should guarantee 4 per cent. interest on the accumulations of the fund. He concluded by moving the adoption of the report and the payment of the dividend and bonus recommended. The Marquis of Tweeddale seconded the motion, which was carried. The chairman afterwards proposed, and Sir James Anderson seconded, a resolution approving the establishment of a staff pension fund, and authorising the directors to carry out the same upon such terms and conditions as they might think expedient. The motion was unanimously carried.

Elmore's American and Canadian Copper Depositing Company, Limited.

A STATUTORY meeting of the shareholders in Elmore's American and Canadian Patent Copper Depositing Company, was held last Tuesday at Cannon Street Hotel, under the presidency of Sir Francis de Winton.

The Secretary (Mr. J. Shurmer) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the present being nothing more than the customary statutory meeting of the company under the Limited Liability Act, by which a meeting of a company is required to be held within a comparatively short time of its formation, there is little or no business to be transacted. We propose, however, to take advantage of the meeting to sanction an alteration in our articles of association, in order to comply with the requirements of the Stock Exchange Committee, to whom we have applied for a special settlement and official quotation of our shares. That body required that No. 92 of our articles of association should be eliminated. It reads as follows: "The directors shall have full power to execute, in the name and on behalf of the company, in favour of any director or other person who may incur or be about to incur personal liability, whether as principal or surety for the benefit of the company, such mortgages or charges on the company's property (present and future) or uncalled capital as they think fit, by way of guarantee to or for the indemnity of such director or person, covenants, and provisions as shall be agreed upon." As such elimination is entirely in the interests of the shareholders, I have no doubt that you will sanction it, and a further meeting will have to be called in about a fortnight's time to confirm the resolution. As to the proceedings of the company since its formation, I may say that out of the 65,000 priority shares offered to the public for subscription, 45,000 have been allotted amongst 700 applicants, and the amount outstanding on calls is comparatively small. The board lost no time in obtaining tenders for the supply of the plant required to be erected in America to carry out the objects of the company as set forth in the prospectus. We further hope, by an arrangement with the directors of the other Elmore companies, to invite the experts of the intending purchasers to visit the works of the English and French companies, and there to demonstrate to them the real success of the process on a large commercial scale. Difficulties have always been encountered after putting up new works and starting a new process. When we make allowance for such difficulties we shall find that but little time, since the first Elmore company was formed, has been wasted, and I have no reason to doubt that the English companies are at the present moment in a satisfactory condition. Such being the case in one country, it follows, as a matter of course, that the same can be done in other countries with proper management, where there is a considerable copper consumption, and I am convinced, gentlemen, that in the American and Canadian Elmore Company we have an investment inferior to none of the others. You must bear in mind that our company is not formed for the purpose of manufacture, but to exhibit and re-sell the American and Canadian patents; therefore, it is most unlikely that there will be any delay in our operations, such as have had to be encountered by the European manufacturing companies. The secretary asks me to remind you that the fully paid share certificates of the company are ready to be issued in exchange for allotment letters and bankers' receipts. Before proposing the resolution for the alteration of the article, I will invite any shareholder present to ask any questions relating to this company which he may desire to ask, and which we will answer to the best of our ability. I beg now to move: "That Clause 92 of the company's articles of association be, and is hereby, rescinded and annulled."

Colonel P. MOSELY seconded the motion.

A SHAREHOLDER asked whether the object of the company was merely to sell the patents, and not to work at all.

The CHAIRMAN said that, according to the prospectus, the company was formed simply for the purpose of re-selling the patents. They proposed to put up a small plant in America simply for the purpose of demonstrating the practicability and the commercial value of the process; but, having the large companies in England and France already at work, they thought it would be only spending the shareholders' money in a doubtful way to work the process in America. Negotiations were already pending, but he thought it premature to speak of them.

The resolution was then put and carried, and, with a vote of thanks passed to the chairman, the proceedings terminated.

The Metropolitan Electric Supply Company, Limited.

THE directors' report for the year ending December 31st, 1891, states that during the year the company has been steadily extending its system of underground cables, and except in certain of the outlying portions of the company's areas, all the more important thoroughfares are provided with mains. The directors are pleased to report that all the company's stations have worked satisfactorily. The generating station for the Paddington district, which has been in course of construction during the past few months, will be completed almost immediately. The expenditure upon works of construction during the year has been £113,580, making a total capital expenditure to December 31st, 1891, of £486,926. This practically absorbs the company's capital. Additional capital is required for the completion and equipment of the Paddington installation, supplying a wealthy and important district which the company has been successful in securing since its incorporation. Provision may also have to be made for certain street lighting, and other contemplated extensions of supply. The board propose to meet the outlay for these purposes by a debenture issue not exceeding £100,000. The terms of such issue are now under the consideration of the board, and the debentures will be offered in the first instance to the shareholders. The gross revenue for the year amounted to £43,747 1s. 3d., including a sum of £3,027 1s. 3d., paid by the contractors on account of expenditure incurred by the company in working the Sardinia Street, Rathbone Place and Manchester Square installations during the time of testing, &c. The net revenue for the year was £9,719 10s. 8d., which enables the directors to recommend a further final dividend of 2s. per share. The company's lamp connection, which on January 1st, 1891, was equivalent to 48,000 8-candle-power lamps, rose during the year to 82,000 lamps. It now amounts to 96,000 lamps, and continues steadily to increase. With this increase the percentage of net profit may be expected to grow rapidly, as there will be no corresponding increase in the fixed charges. It is with much regret that the board have to record the death of their colleague, Alderman Sir R. N. Fowler, Bart, M.P. The vacancy thus caused has been filled up by the appointment of Admiral of the Fleet Lord John Hay, G.C.B. In accordance with the articles of association, the following directors, viz., J. Denison Pender, Esq., Admiral Sir George H. Richards, K.C.B., and John Benjamin Verity, Esq., retire from the board, and being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., retire, and offer themseves for re-election.

ABSTRACT OF ACCOUNTS TO DECEMBER 31ST, 1891.

CAPITAL ACCOUNT.

Dr.	£	s.	d.
To Expenditure per last account	363,886	3	6
„ Further expenditure to December, 1891	123,040	3	4
„ Balance	10,560	2	2
	£497,486	9	0

Cr.	£	s.	d.
By Ordinary shares of £10 each	496,486	9	0
„ Founders' shares of £10 each	1,000	0	0
	£497,486	9	0

REVENUE ACCOUNT.

Dr.	£	s.	d.
To Generation of electricity	26,694	14	7
„ Distribution of electricity	163	5	9
„ Proportion of rents, rates, and taxes	2,644	6	3
„ „ management expenses	4,015	16	6
„ „ law and Parliamentary charges ...	40	9	8
„ Insurances	468	17	10
„ Balance...	9,719	10	8
	£43,747	1	3

Cr.	£	s.	d.
By Sale of current per meter	22,683	0	10
„ „ „ under contract	15,084	8	3
„ Rental of meters, converters, &c.	1,816	19	11
„ Transfer fees	57	9	6
„ Other items	1,078	1	6
„ Amount allowed by contractors	3,027	1	3
	£43,747	1	3

NET REVENUE ACCOUNT.

Dr.	£	s.	d.
To Bank charges and commission, interest account, allowances to electric light customers, and bad debts	552	18	7
„ Interim dividend of 2s. per share, paid May 1st, 1891	4,708	0	8
„ Balance applicable to dividend on ordinary stock or shares	5,454	19	10
	£10,715	19	1

Cr.	£	s.	d.
By Balance from account	461	10	2
„ „ „ revenue account	9,719	10	8
„ Discounts	534	18	3
	£10,715	19	1

GENERAL BALANCE SHEET.

Dr.	£	s.	d.
To Capital account	497,486	9	0
„ Sundry tradesmen and others, on construction of plant, machinery, fuel, &c.	21,888	2	5
„ Sundry creditors on open accounts	788	1	3
„ Temporary loans	9,606	14	3
„ Net revenue account, balance at credit thereof ...	5,454	19	10
	£535,224	6	9

Cr.	£	s.	d.
By Capital account	486,926	6	10
„ Cash at bankers	14,183	4	4
„ „ in hand	5	18	9
„ Sundry debtors for current	14,314	13	11
„ Other „	3,785	5	2
„ Stores on hand	5,043	16	11
„ Preliminary expenses	5,052	10	4
„ Deposits	5,912	10	6
	£535,224	6	9

The Brazilian Submarine Telegraph Company, Limited.

THE following is a copy of a letter which was circulated amongst the shareholders of this company on the 29th ult.:—

"Dear Sir,—You will no doubt have seen in the papers of yesterday and to-day the prospectus of the South American Cable Company, Limited, and observed that it is based upon the annual returns of this company for the past 5½ years. As this is so, I would point out that the figures given in the prospectus as this company's income from South American traffic include, in fact, the company's traffic from the West Coast of Africa and the Cape Colonies, which is not an inconsiderable item, and which cannot accrue to the new company.

"It will be remembered that for some time past the South American traffics have been abnormally high, owing to a series of political and financial disturbances in various Republics of South America. With a more settled condition of affairs, the traffic has now fallen to a more normal state, which resulted in the half year ending December, 1891, in a receipt of £125,244, and for the period from January 1st last to date, it has been at the rate of £109,000 for the half year, as compared with £170,026 given in the prospectus for the corresponding half year of 1891. The estimate, therefore, of traffic to a competing company, taken on the basis of £170,026, must be reduced by at least one-third.

"You will no doubt have also noticed in the public prints of the 29th inst. (April), the intimation of the reduction of rates over the competing existing line *via* Galveston and the West Coast of America. This reduction the company have now to face, as well as any other reduction which might follow from the laying of an additional cable, and the competition of the Antilles cable when completed, all of which must materially and adversely affect the prospects of the new company as set out in the prospectus. It is not apprehended that these circumstances will so prejudicially affect this company as they must any competing line, the Brazilian Company having a joint purse agreement with the Western and Brazilian Telegraph Company, who cover the collecting ground for messages from Brazil and the east coast of South America. Moreover, this company have two cables between Lisbon and Pernambuco, and the duplication of the Western Company's line from Pernambuco to the River Plate will be completed in the course of a few days.

"Your directors, therefore, consider that the revenue of £85,000 per annum, which the new company anticipates from their single cable, is considerably over estimated.

"Your directors think it right that you should have this information before you, as they consider that whilst the new company may prejudicially affect your interests, that company will be unable to reap a corresponding advantage to themselves, and your directors, therefore, recommend that you should not support the new enterprise.

"By Order,

"RICHARD COLLETT, *Secretary*."

The thirty-seventh ordinary general meeting of this company was held on Wednesday last (4th inst.) at Winchester House, Old Broad Street, E.C., Sir James Anderson presiding.

The SECRETARY read the notice convening the meeting, also the minutes of the previous meeting.

The CHAIRMAN stated that, with the shareholders' permission, he would read what he was going to say, as what with competitions, and other things, he wished to be exact in what he told them. As they had had the report and accounts before them for some time, he presumed he need not do more than, as usual, call their attention to some of the chief points. There was a decrease of revenue of £31,800 as compared with the previous half-year, but he must remind them that the accounts of several previous half-years had included abnormally large receipts arising from exceptional causes in South America. The existence of a more settled state of affairs had resulted in a falling off of the exceptional traffic, and that accounted largely for the large decrease of £32,000. It was, however, chiefly due to the abnormally low rates of exchange, and which, he was sorry to say, still continued. They could only hope that by-and-bye the value of the Brazilian currency would improve. There had been an increase in the expenditure of £7,037, of which the bulk was attributable to the additional cost of repairs of cables and to duplexing their newest cable. They must prepare for expenditure upon repairs at all times, as their cables, as they got old, would have to be repaired. The expenses of applying duplex working to No. 2 cable amounted to £3,000, of which £587 was the cost of training the necessary operators to work the duplex system, and further strengthening their staff for continuous day and night service, so as to create a speed and accuracy which could not be excelled, and he (the chairman) hoped would not be easily equalled, as their whole system had been duplexed, which all their rivals had not yet done with all that they had projected. After paying two interim dividends at the rate of 6 per cent., they carried forward the sum of £19,893, and he would be disappointed if the shareholders did not, as usual, receive a bonus at the end of the financial year (next October). He was glad to say that the current year's working was not unsatisfactory. There was one other matter he would like to refer to, they were aware that the cables of the Western and Brazilian Company were partly duplicated, but it required the laying of a second cable between Santos and Chuy, to provide complete duplicate service between Great Britain and Buenos Ayres; the want of that complete duplication prevented the service with the River Plate being entirely satisfactory to their directors as a strong competing line; and as it was at Buenos Ayres that the Central and South American Company had agreed to compete for the Brazilian Submarine Company's traffic, they had agreed that the Western and Brazilian Company should lay the necessary cable, which, he believed, was to be landed that day (Wednesday); in fact, they had had a telegram within an hour before the meeting to say that they were landing. He believed that this would lead to results greatly to their mutual advantage, and success in dealing with their competitors. The cost incurred by the Western Company had been very large, and as the Brazilian Company's fair contribution, the directors had agreed to pay the Western and Brazilian Company a sum of £6,000 per annum, instead of making any alteration in the percentages of the joint purse. In addition, the Western Company gave them the right to use their repairing cable ship at a moderate charge per day; this would save the expense of fitting out a steamer in Europe, and sending it to and from Brazil at any time it might be needed for repairs. He was sure they had done the best they could in the shareholders' interests. They could not compete unless they had the right tools to work with, and this was indispensable. He thought he need not further dilate upon the revenue and expenditure, but go on to say what he wanted to in respect to the further and future aspect of their affairs, as that subject pressed more upon his own mind. First, then, it was true that their existing rivals on the west coast of America had forestalled them in securing the Transandine line between Buenos Ayres and Valparaiso, and arranged the traffic so as to shut them out, so that they lost all the Chilian and Peruvian traffics, but for the present only. The companies interested, namely, the West Coast of America, Western and Brazilian, and their own company, were arranging for the construction of an independent Transandine line between the Atlantic and the Pacific, and then they would see how far their rival, the Central and South American Company, could keep the ground it had taken. The Central Company had commenced cutting rates, whereas their own company had carried out a policy of gradual reductions, as circumstances permitted, which ranged from 33 to 50 per cent. of the old rates. He said that they were prepared, whenever they saw it in the shareholders' interests, to accept a challenge not to retain a higher tariff than their rivals; but in the meantime they were safeguarding the shareholders' money and interests with every care. They knew what the French Antilles Company, which was their second rival, were trying to do; but unless they had Government subsidies, it did not appear that they were in an enviable position. For all that they must not be despised; they had spent a great deal of money, must spend a great deal more, and the Brazilian Submarine Company might have to encounter a great deal of competition by-and-bye. That company proposed to unite Africa with Brazil by a cable between Senegal and Pernambuco, and so provide another route to Europe via Africa. He might remind them that Africa was already joined to Brazil, and the route to Europe was already in existence, as the Brazilian Submarine Company's cables at St. Vincent were in connection with that of the African Direct Telegraph Company, and, in fact, with the whole world. He did not think he would have felt it his duty to say anything against the new company, whatever he might have thought, because contractors had a right to keep their machinery going if the public would find the money, or if they were rich enough to risk their own money; but in their prospectus they held the Brazilian Submarine Company up as the one they intended to injure. They had also based their estimates of revenue on a few exceptional years, when civil war by sea and land, revolution, and financial crisis caused reckless telegraphing and expenditure, which naturally inflated this company's receipts at a time when every other means of communication with

the outer world than by their East Coast cables was stopped. The prospectus complacently estimated that the new company might expect to take from their company £85,000 per annum of the extraordinary receipts to which he had referred, but those receipts had already gone down, the advent of peace had already diminished them, from one cause or another, by one-third, so that it took something off the £85,000. The tariffs were reduced, whilst the loss of exchange on the charges collected in Brazil was equivalent to another very large reduction. The prospectus stated that the Brazilian Company was making a lot of money; they gave data which he could assure them would prove disappointing. The company had, however, been formed, the ship had sailed with the cable, and they must meet the competition. One could not see three rival companies preparing to attack them, and speak to the proprietors as if it were a trifle. At the last meeting he stated that he was not in a desponding mood, and neither he or his colleagues were inclined to be so now, though they were of course anxious. They would prevent their rivals taking from them that £85,000, or anything like it. They could look with great satisfaction upon their position. The entire system of the company was duplicated, and the last new cable was duplexed, giving a carrying capacity of three cables; and that of their partners, the Western and Brazilian Company, between their point of landing at Pernambuco and the River Plate, was completed and the duplex working between London and the River Plate would now be arranged for. Their traffic was being transmitted with great speed, which they were improving every month. They had duplicated their cables without increasing their capital, and they had a substantial available reserve for extensions of contingencies. Their receipts from the West Coast of Africa and the Cape colonies were of considerable importance, whereas their rivals' calculation was as if all the company's revenue resulted from the traffic between Pernambuco and Europe. They would also soon have a direct line across the Andes to Chili, and all the way to Lima—in fact, a complete thorough communication from Peru and Chili to Great Britain and Europe. Nothing that forethought or a judicious expenditure of their money could have done to strengthen their position had in his opinion, been neglected. He then proposed that the report and accounts to December 31st, 1891, submitted to the meeting be approved and adopted.

This was seconded by the Hon. W. ST. JOHN F. BRODRICK, M.P., and carried unanimously.

A SHAREHOLDER asked what the approximate cost of the Transandine line would be, and how they proposed to meet the cost, whether out of the revenue.

The CHAIRMAN stated that the cost would not be very great, and the three companies were united in making it. It would be about £100,000 or £120,000, the whole of the Brazilian Submarine Company's share being about half. They anticipated that there would be traffic enough on it to pay well. The three companies would be united in making the line. This company's proportion of the cost would be one-half, but he did not expect any loss upon the outlay—in fact he rather thought it would be a good investment. It was expected by the South American Company that their cable would be open for traffic in July next. A project was now being discussed in Lisbon to give both their company and the Eastern Company an extension of their monopoly for ten years if they would connect with the Azores. He did not know whether they would get the work, as the French company were striving hard in the same direction. If the Brazilian Submarine Company succeeded it would cost them £50,000 but they would have a splendid monopoly.

The motion was adopted.

A question was asked as to when the new South American line was expected to be opened.

The CHAIRMAN stated that the ship sailed last week, and it was expected that the line would be completed in July next.

The report was then unanimously adopted.

A vote of thanks to the chairman and directors having been acknowledged by Sir James Anderson, the proceedings terminated.

The Western and Brazilian Telegraph Company, Limited.

THE following is an abstract of the directors' report:—The directors submit their report and the accounts of the company for the half-year ended December 31st, 1891. The total earnings amount to £92,345 4s. 7d., as against £108,817 10s. 5d., showing a decrease of £16,472 5s. 10d., compared with the half-year to December 31st, 1890. It will be observed that in common with other South American undertakings the loss on exchange is heavy, and in this company's case reaches the large sum of £19,133 16s. 5d. But for this loss the revenue would have been in excess of that for the corresponding period. The working expenses amount to £38,404 5s. 1d., as against £37,200 2s. 4d., an increase of £1,204 2s. 9d. Including the amount brought forward from June 30th, 1891 (£6,470 4s. 8d.), and the dividend received upon the shares held in the "Platino" Company, the balance to the credit of the revenue account is £67,798 4s. 2d., from which has been deducted £12,807 for debenture interest, and £6,293 for the debenture redemption fund, leaving £48,698 4s. 2d., of which £15,000 has been placed to the reserve fund. The directors now recommend the payment of a dividend of 6s. per share, free of income tax, for the half-year on the ordinary shares, making, with the dividend paid in November last, £4 per cent. for the year, leaving a balance of £4,486 18s. 2d. to be carried forward. In the case of shares which have been divided into "preferred" and "deferred," 1s. 6d. per share of the dividend now recommended will be payable to the "preferred" shareholders, and 4s. 6d. per share to the "deferred" shareholders. The third annual drawing of the "A" and "B" debentures took place at the company's offices on January 15th last on the presence of Mr. W. W. Venn, jun., notary, when debentures amounting to £12,700 were drawn, and have since been paid off at par. Under a satisfactory arrangement with the Brazilian Submarine Telegraph Company a contract for the immediate duplication of the company's lines between Santos and Chuy has been entered into with the Telegraph Construction and Maintenance Company, Limited, and the expedition to lay the cable is now on its way out. Upon the completion of this additional line, and in consideration thereof, this company will receive a payment of £6,000 per annum from the Brazilian Submarine Telegraph Company. When this cable is laid the lines of the company will be duplicated over the whole of the busy part of the system, namely, from Pernambuco to Montevideo; thus affording, in connection with the through lines working in concert with this company, duplicate lines from Europe to Brazil, Uruguay, and the Argentine Republic. The new cables will be duplexed throughout. The company has entered into a contract for a new repairing steamer in substitution of the *Norseman*. The new ship will be of the best and most recent construction; will be more economically worked, possess greater speed and be more handy in the moderate depths with which the company will now have to deal. As soon as she reaches her station, efforts will be made to dispose of the *Norseman*. The dividend warrants will be posted on May 13th, 1892. The retiring directors are Mr. C. W. Earle and Mr. D. H. Goodsall, who offer themselves for re-election. Notice has been given to the company that Mr. John Coppen is willing to serve as a director, and that at the general meeting on May 12th, he will be proposed for election. The shareholders are aware that at the last general meeting the directors stated that it was not their intention to add to their number, as they did not see their way to fill adequately the place at the board vacated by Mr. Weaver. The directors are of opinion that the appointment of an additional director would be of no advantage in the management of the company's affairs, unless he possessed knowledge and experience of the business of a telegraph and cable company, or special knowledge and influence calculated to be useful to the company in South America. There is a sufficiency already of general business qualifications at the board. Under these circumstances the directors see no reason to depart from the conclusion announced to proprietary last November, and coincided in by a fully attended meeting of the shareholders. The auditors suggest that in future their respective firms should be elected in lieu of themselves as individual partners, and the resolution for the election of auditors should accordingly take this form, viz., "That Messrs. Turquand, Youngs, Weise, Bishop and Clarke, and Messrs. Deloitte, Dever, Griffiths & Co., be elected auditors of the company, and that their joint remuneration (as heretofore) be 100 guineas."

Islington and General Electric Supply, Limited.—The *London Gazette* announces that a petition presented to the High Court of Justice, Chancery Division, on May 2nd, for confirming a special resolution reducing the capital of this company as follows:—"1. That the name of the company be changed to the Islington and General Electric Supply, Limited. 2. That the capital of the company be reduced by cancelling the 100 founders' shares of £1 each. 3. That the ordinary shares in the capital of the company be consolidated in such manner that every five thereof shall constitute one £5 share," is directed to be heard before his Lordship, Mr. Justice Chitty, to-morrow, May 7th, 1892. Creditors or shareholders desirous of opposing the reduction of the capital are required to appear at the time of hearing, or be represented by counsel.

Anglo-American Telegraph Company, Limited.—The Anglo-American Telegraph Company, Limited, state that the rate for the transmission of telegrams by their lines, "*viâ* Galveston," to all places in the Argentine Republic, Bolivia, Brazil, Chili, Ecuador, Paraguay, and Peru is now reduced to 6s. 2d. per word.

Elmore's French Patent Copper Depositing Company, Limited.—Letters of allottment of 10 per cent. preference shares of Elmore's French Patent Copper Depositing Company, Limited, have been posted.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of April were £3,700 as compared with £3,760 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of April, 1892, were £1,785, against £1,835 in the corresponding period of last year.

The Eastern Extension, Australasia, and China Telegraph Company, Limited. The traffic receipts for the month of April, 1892, were £38,824, against £44,729 in the corresponding period of 1891.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of April, 1892, were £53,683, and £60,909 for the same period of 1891 decrease, £7,216.

The Great Northern Telegraph Company. Receipts in April 1892, were, £20,000 1st January—30th April, 1892, £82,800; corresponding months, 1891, £88,000; corresponding months 1890, £81,800.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 29th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £3,275.

The West India and Panama Telegraph Company. The receipts for the half-month ending April 30th were £2,669, against £2,984.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation, April 28th.	Closing Quotation, May 5th.	Business done during week ending May 5th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48½ — 49½	48½ — 49½	48⅝	48½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½ — 88½	87½ — 88½	88¼	87½
2,849,510*l*	Do. do. Deferred	Stock	11 — 11½	11 — 11½	11⅜	11 3/16
130,000	Brazilian Submarine Telegraph, Limited	10	10½ — 11	10½ — 11	11 3/16	10⅝
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	3 — 3½	3⅛	3 1/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2½	2 — 2½	2 3/16	2 1/16
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½ — 4⅛	3½ — 4⅛	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3⅛	2½ — 3⅛	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	7½ — 8	7½ — 7⅞	7⅞	...
$7,716,000	Commercial Cable, Capital Stock	$100	155 —160	155 —160	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/8 — ½	5/16 — 7/16	7/16	3/8
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 5⅝	5½ — 5⅝	5¼	...
16,000	Cuba Telegraph, Limited	10	10½ — 11½	10½ — 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	16½ — 17½	16½ — 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½ — 3⅝	3½ — 3⅝	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 11⅝	11⅜ — 11⅝	11⅝	11 7/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜ — 14⅝	14⅜ — 14⅝	14⅝	14 1/16
70,000	Do. 6 p. c. Preference	10	15½ — 15⅝	15½ — 15⅝	15⅝	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	108	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110xd	107 —110 xd	110	108
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15½ — 15⅝	15½ — 15⅝	15⅝	15½
78,300*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	102 —105	102 —105	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	104	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	100 —103	102½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5⅜ — 6¼	5⅜ — 6¼	6 1/16	6⅛
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1½ — 1⅝	1½ — 1⅝	1⅝	1⅛
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅛ — 2⅜	2⅛ — 2⅜	2⅜	2⅛
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	1⅜ — 1⅝	1⅜ — 1⅝	1½	1⅜
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10 — 10¼	10 — 10¼	10¼	10 1/16
180,042	Do. do. 6 p. c. Preference	10	15⅛ — 15⅜	15⅛ — 15⅜	15⅜	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	19 — 19½	19 — 19½	19⅜	19⅛
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	108⅛	108
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅜ — 8¼	7⅜ — 8¼	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10½	9½ — 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20 — 21	20 — 21	20⅞	20½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —105	102 —105	104	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	41	39⅛
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ...	10	4½ — 5½	4 — 5	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3⅜ — 3½	3⅜ — 3½	3½	3⅛
10,000	Do. do. fully paid	5	5 — 5⅛	5 — 5⅛	5 1/16	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8½ — 8⅝	7½ — 8	8 5/16	7⅝
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 4⅝	4½ — 4½	4 9/16	4 5/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13 — 13½	13½	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12½	12 — 12½	12½	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	106 —108	107 —109	108	107½
250,000*l*	Do. (issued at 5 p.m., all paid)	...	104 —106	104 — 106	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½ — 5½	4½ — 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼ — 3/8xd	5/16 — 7/16 xd	¼	...
9,000	Reuter's Limited	8	5½ — 6½	5½ — 6½	6 1/16	5½
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼ — 8⅜	8¼ — 8⅜	8⅜	8⅛
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7½ — 8	7½ — 8¼	8	7⅞
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	115½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3¾ — 4¼	3¾ — 4¼	4 1/16	4
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	42⅝
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	100½	99½
30,000	West Coast of America Telegraph, Limited	10	2½ — 3½	2½ — 3½	3	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	9½ — 10	9½ — 10	9⅝	...
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	...	...
30,364	Do. do. do. 5 p. c. Deferred	7½	3⅜ — 4¼	3½ — 4	3⅜	3½
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝ — 1⅞	1⅝ — 1⅞	1 15/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10½	10
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	99 —103	99 —103	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	115 —119 xd	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	100½	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½ — 7	6½ — 7	6⅝	6 5/16

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7⅛—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2—2½.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6¾—7¼.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—7 per cent. Preference Shares of £5 (fully paid) 5¼—5⅝.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¼—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5—5⅛.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ¼—⅜.—£5 Preference (fully paid), 2½—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCOUNT.—2 per cent. (April 20th, 1892).

APPLICATION OF ELECTRICITY TO HOISTING MACHINERY.*

BY REGINALD BOLTON, A.M.I.C.E.

HOISTING and hauling gear is of infinite variety, and being, perhaps, the most ancient form of mechanical appliance, has suffered most, in later times, from incrusted conservatism and prejudice.

There are cranes in active use, now, on some of the early docks which have seen an unmodified existence of a century, and whose main features are reproduced with fidelity, though probably with less likelihood of such extended service, in the cranes of our present makers.

The application of steam to cranes was a substantial advance in the direction of increased power and isolated points of generation, and that of hydraulic power, despite its inherent disadvantages, was a still greater step in affording the means of distribution of that power, while the utilisation of compressed air for a similar purpose is equally practicable, but has not received the development which its manifest advantages afford, by reason chiefly of its low economy, which the author considers is still capable of considerable improvement.

The use of high and low speed ropes, belts, and shafts is extremely widespread in effecting the propulsion, in certain positions, of hoisting machinery, and in manufacturing engineering scarcely a workshop or a warehouse exists wherein some one or other form of its transmission of power is not thus employed.

The whole essence of the application of electric force in this connection lies in its sub-division and transmission over a distance. It is essentially a transmitter, and not a generator, of power. It is, evident, therefore, that these competitors are chiefly systems of distribution, not isolated and self-contained applications of force. Thus it has to compete with steam and water power, compressed air, flying ropes, tumbler shafts and gear, hand power, and show inherent advantages over any and all, and, in addition, present a considerable economy; while the first cost must be within reasonable limits. The author has divined its distinctive advantages in these comparisons as follows:—

Cheapness.—Where electric plant is in existence the first cost of an electrical crane is even less than a steam crane.

Handiness.—There is no raising or laying down steam, no carriage of coal and water to difficult positions. The crane is always ready while the current is on. No feed pump to attend to.

Cleanliness.—There is no steam, water, heating, ashes or sparks; the gearing is always cool to handle.

Safety.—While steam cranes add to insurance the electric crane does not. The tension of 110 volts is absolutely harmless.

Quick Work.—The power is so directly applied that more can be got on to a crane than by any other system. By suitable arrangements loads can be handled and adjusted to a hair's breadth.

Variable Power.—The motor takes only the power required to lift the particular load opposed to it; in this respect comparing most favourably with the hydraulic system.

Economical Working.—When not in use the electric crane wastes no power like rope and shaft travellers, no fuel like steam cranes. No time is lost in raising steam, in fetching fuel, stoking or fetching water. As the crane can be controlled from a considerable distance, the operator may be placed in the very best position to deal with his work.

Simplicity of Gear.—Finally, for the special purposes of propelling hauling gear, the electromotor possesses the especial merit of a high and regular initial speed, capable of reduction by simple means to any given rate of speed.

As general design has an important bearing upon the successful work of the machine, it should be noted that it will not suffice to treat the motor as a mere rotating instrument to be connected up to the hoisting gear in the manner of an ordinary steam engine, and treated as such.

Motors are, of course, of considerable variety, and can be obtained in many forms, with high or low centres of rotation, and to suit all varieties of tension and capacity. They all possess, however, certain special eccentricities, which have to be carefully provided for in any application to mechanical duties, especially to those of an irregular character, and it is to the means of so doing that the author desires to direct attention. The most important peculiarity is their capacity for usurping and developing power for which they are unfitted. This may be described as a saturating process, or "sucking up," wherein the motor will, if supplied with a certain current, utilise as much of it as corresponds with the resistance imposed upon its rotation. It will be perceived how extremely useful and advantageous such a natural capability is, until it exceeds the designed limit of the machine, when it immediately becomes a danger, inasmuch as the carrying capability of the wire, connections, commutator, and brushes, may be overrun, and heating thereby set up to such an extent as to burn out or destroy the insulating materials. It will be evident that this effect is most likely to be found in cases of overloading the motor with mechanical work, and that this is especially likely to be the case in connection with hoisting machinery. A like result may be feared if an excess of current be switched into connection with the idle motor, for then current which would not be excessive for the actively repeated passage of the moving coils of an armature, may be too much for that particular coil which happens to be in the position of receiving or transmitting the entire amount. This is more particularly probable in the case of reversible motors, wherein it is possible that a reversal of the full current may take place even before the complete stoppage of the motor.

Thirdly, there is in the reversal itself a possible disadvantage, in the liability to sparking at the brushes during the period of stoppage and re-starting.

Lastly, a direct connection of the motor shaft to spur gearing is liable to produce injury by excessive vibration to the commutator of the machine.

These peculiarities sum up the weaknesses of electro-motors, which are, in all other respects, admirably effective, simple and useful machines, developing, as they do, the force supplied to them in the most direct manner possible at a high initial speed, with the minimum of working or wearing parts, and with extraordinary efficiency, amounting to as much as 90 per cent. output of the energy delivered into them.

At the outset, then, it appears that a motive engine, possessing such excellent qualifications, is likely to produce results superior to those of more complicated and inefficient mechanism, and experience fully bears out the assumption.

The author, by a study of the American practice in electrical cranes, and of the foregoing considerations as regards the motor, arrived at the conclusion that the secret of the successful application of the system to hoisting machinery lay in the direction of adaptation of that machinery to the essential features of the motor, and not in the bare connection of the latter to existing contrivances.

For an entirely satisfactory adaptation of electricity to a crane, there are thus several conditions.

From the Mechanical Point of View.

(*a*) It should be impossible to overload the motor.
(*b*) The motor should not be reversible.
(*c*) The load should be brought to bear upon the motor gradually, without shock.
(*d*) The connection of the motor to the crane gear should not be by direct toothed gearing.
(*e*) The gearing should be direct and simple.

And from the Electrical Point of View.

(*f*) The motor should be run at a continuous speed.
(*g*) It should be impossible to over-supply it with current at starting.
(*h*) No end thrust should be permissible upon the motor shaft.
(*i*) The field magnets should not be short-circuited by the metal of the crane.

It is to be regretted that these conditions, perhaps from lack of consideration, have been in some cases neglected by designers, with unfortunate results; though, no doubt, such occurrences are probable in the initiatory stages of any new applications of energy.

It is, on the contrary, a satisfaction to be able to point to numerous instances of successful installations where the proper conditions have been applied, and the author would add that there is no reason why very considerable success should not attend the addition of electro-motors to many existing hand, steam, or power cranes and engines, provided that the connection is made with proper safeguards. To comply with the whole of the recited conditions, the author designed a special system of crane-gearing and a frictional safety connection between the motor and gear, the subjects of his patents of 1890 and 1891.

These details are all combined in the construction of the electrical ship's-winch, which has proved a practical success in all the conditions it has worked under.

Turning now to the question of overhead travellers, the author draws attention to a traveller designed for erecting-shop and foundry use. The gearing is all at one end, and the operator is seated in a cage below it, close to the motor, which is easibly accessible. The general arrangement corresponds with the best modern practice, and the entire motions of the crane are controlled in full view of the load. The arrangements of motor, safety device and gear and reversing motions are based on the same design as the preceding.

The load is always sustained by the worm attached to the winding barrel or barrels, and it must be reversed to lower. This it does, however, at a higher speed; all the motions are reversed by frictional sliding or expanding clutches from one motion shaft driven by the motor, but operating without shocks. The current is supplied by an overhead, or side, bare copper conductor, upon which is pressed a copper shoe on a spring rod mounted on the crane and connected by a lead to the crane switch. The switch is designed so that on its being thrown over it supplies current first to the field magnets, next through a resistance to one brush, then fully to one brush, next through a resistance to the other brush, and then fully to both brushes. This arrangement works admirably, the motor starting and stopping with ease and certainty.

The foregoing description applies to the electrical cranes constructed by the author. This crane lifts a maximum load of 2½ tons, or in ordinary work 2 tons, with a motor of 5 H.P., supplied with current at only 40 volts.

In simplicity, quietude and rapidity, these electrical overhead travellers far surpass the best rope or shaft travellers extant, and no one who has once worked one could fail to be impressed thereby. When it is recollected that the motor absorbs only that amount of power usefully utilised, and none at all when it is stopped between lifts, that its high speed enables very direct and simple gear to be employed, and that it is in itself an extremely efficient engine, the remarkable results attained by the use of electricity in this connection are easily explicable.

Mr. Earl, of the London and North Western Railway, at Crewe, conducted a careful experiment with a view of establishing the relative merits of a rope and electric crane, and although this was not

* Abstract of paper read before the Society of Engineers, Monday, 4th, 1892.

done in a manner advantageous to the latter, yet the following was the striking result:—

A load of 8 tons was first lifted by the crane as it stood before alteration, when the power absorbed was found to be 19·5 H.P. The crane gear was then attached to an electro-motor mounted on the crane, when the same load was lifted at the same speed, with an expenditure of only 11·1 H.P. This is a remarkable economy of no less than 43 per cent.

At Messrs. Macintosh, Seymour & Co.'s works at Auburn, New York, there is an electrical traveller of 15 tons power, with a longitudinal traversing motion of over 300 feet per minute, and a cross traverse of 120 feet per minute, and with this weights can be handled in any direction to $\frac{1}{16}$th of an inch by the operator in the cage. The owners state that it represents a great saving in power and time over their previous mechanical cranes.

At the Morgan Works, Alliance, Ohio, there is a 15-ton traveller, which works with most remarkable smoothness, ease, and economy. Every crane in these important works has been altered into electrical driving with success and economy. A small high speed engine driving a Thomson-Houston dynamo, in a small engine room almost without attendance, supplies all the power.

At the Altoona Works, on the Pennsylvania Railroad, there is a traveller of 100 tons power, built by William Sellers & Co., which proves a highly successful and useful machine, and by it a 65-ton locomotive is lifted and transferred in five minutes, an operation which previously occupied many hours. The result is partly due to the use of two independent crabs with separate motors upon them.

Finally, it may be argued, that all these conditions must be produced at a serious extra first cost, but such is not really the case, as the following comparative estimate will suffice to show, while a far larger outlay on the electric installation would be not only justifiable but judicious, in respect of the serious gain in economy of power and labour.

Cost of a 25-ton overhead square-shaft traveller, complete	£675
250 feet of square-shaft, with tumbler bearings every 12 feet...	£160
Driving pulley and belting	£ 12
	£847
25 ton overhead electric traveller of equal speed and power, complete, with motor	£680
250 feet of copper leads and insulators	£30
Dynamo and switchboard	£145
	£855

The efficiency of the two would be as 65 to 100 on any given load, while in a day's labour the economy of cost would be very largely in favour of the electric crane.

The use of electricity in out-door and movable cranes is in its infancy, and only two or three examples exist of the application. It is regrettable that these have been limited in their results, owing to the neglect of those precautions of design, the adoption of which in the case of shop travellers has produced such success.

At the same time, the subject is exciting a wide interest, more particularly among owners of large numbers of isolated cranes, such as docks and harbour authorities. In these cases, the question of relative economy with other systems comes largely into view, and as it is difficult to obtain definite figures, the author tabulates a comparative estimate of three systems, based on exactly similar conditions, and upon precise calculations of cost:—

Comparative Cost and Efficiency of an Isolated Plant under Similar Conditions for Providing Power to 12 Cranes of 2 Tons each, at a Distance of 350 Yards to the Nearest and One Mile to the Furthest.

System.	Pressure.	Cost of generating plant.	Size of main.	Cost of mains and connections.	Cost of identical cranes.	Total cost.	Guaranteed efficiency of system.
Compressed air.	75 lbs.	£2,037, with reservoirs.	8-inch diam.	£1,781	£4,500	£8,218	Cold air 26 per cent. Hot air 34 per cent.
Hydraulic ...	1,500 lbs.	£4,658, with accumulator.	4-inch diam.	£1,212	£4,620	£10,490	45 per cent.
Electrical ...	400 volts.	£4,918	1 inch square.	£550	£6,192	£11,660	70 per cent.

FULL TEXT OF THE RECENT STORAGE BATTERY DECISION.*

[United States District Court, Southern District of New York. The Accumulator Company *v.* the New York and Harlem Railroad Company. Final hearing, in equity. Frederic H. Betts for complainant; Thomas W. Osborn for defendant. Justice Coxe.]

This is an action for infringement of re-issued letters patent, No. 11,047, granted to the Electrical Accumulator Company of New York, as assignee of Joseph Wilson Swan, on December 17th, 1889, for an improvement in secondary batteries.

The invention of the re-issue is intended to facilitate the construction of secondary battery plates by preparing them with perforations, cells or holes, extending through the plate, in which holes the active material is packed.

The original patent, No. 312,599, dated February 18th, 1885, was considered by this court in the case of the Accumulator Company *v.* Julien Company, 38 Fed. Rep., 117. The original was held invalid (page 140—142) for the reason that it described and claimed a plate, the outer surface of which might be covered by the active material. This construction, in view of the work done by Prof. Eaton, was held to be anticipated.

The theory of the re-issue is that the valuable feature contributed by Swan consists in confining the active material to the holes, without permitting it to extend beyond them to the surface of the plate. That portion of the original which refers to the coating of the outer surface of the plate, has been omitted in the re-issue. In other respects the description is unchanged.

The claim is as follows:—

"A perforated or cellular plate for secondary batteries, having the perforations or cells extending through the plate, and the active material, or material to become active, packed in the same perforations or cells only, substantially as described."

This is the claim of the original, except that the word *only* has been added.

The patent cannot be criticised as a re-issue. The claim, instead of being broadened, is greatly restricted. The application was filed within a reasonable time after the inventor was informed of the facts which made a narrower claim necessary. The facts bring the case within the provisions of section 4,916 of the Revised Statutes.

The field of invention is, concededly, a narrow one.

The counsel for the defendant correctly states that Swan's improvement consists "wholly in the idea of putting on the surface of a perforated plate for secondary batteries no active material beyond the contents of the perforations; everything except this is conceded to be old."

The date, *de jure*, of Swan's invention is January 18th, 1882. Prior to that time Prof. Eaton had filled the perforations, but he had covered both sides of his plate as well. Mr. Brush had rammed or pressed absorptive substances, in the form of dry powder, into grooves or receptacles without covering the surface of the plate. No one had packed active material into holes extending through the plate, confining it entirely to these holes. This combination was original with Swan. Did it involve invention? In approaching this subject it is well to remember, as the court has frequently had occasion to remark before, that we are dealing with a comparatively new and abstruse art, where the most important results are said to follow from changes, apparently, of the most unimportant character.

Complete success has not been attained, but, if we may credit the statements of those who are entitled to speak *ex cathedra* on the subject, the rapid strides in that direction during the last decade are due to changes of form and material which, in many other arts, would be insufficient to support invention.

The substitution of one material for another in a door knob is the work of the mechanic, the substitution of one material for another in secondary battery electrodes may solve a problem which will revolutionise the motive power of the world.

In holding that there is sufficient invention disclosed to support the re-issue, the court is influenced by the following considerations:—

"The Swan electrode is to-day the electrode of commerce. It has largely taken the place of other structures, and is almost universally used. The advantage of having the active material composed of small disconnected masses, packed in holes extending through the plate, is unquestioned. The electrolyte is thus permitted to reach and operate upon both sides of these small masses, instead of on one side where the active material is packed in cells or pockets. The expansion and contraction of the electrode when the battery is in use causes the active material, if packed in cells or grooves or spread upon the surface of the plate, to crack, and portions of it to be pushed out of place and to fall away. These defects which produce "buckling," "short-circuiting," and other disastrous results are entirely remedied by the Swan construction. If one of the small masses in his plate becomes injured or falls out it does not affect injuriously the other parts of the electrode.

As Sir William Thomson puts it:—"The perforated plates have also the great advantage of extending the area of electric communication between the continuous metallic conductor and the porous or spongy material, and so minimising the electric resistance. The application of the oxide in the form of numerous mutually detached parts, separately held by the perforations, has also a great advantage in almost annulling the warping or fracturing effects of oxidation to which the active material is exposed in the charging and discharging of the battery."

It is true that the step from the structures of Eaton and Brush to

* New York *Electrical World*.

the electrode of Swan seems to be very short when looking back upon the work of these men. But, standing where Brush and Eaton did, and looking forward to the ideal electrode which should avoid the then existing difficulties, and possess the excellencies of the present Swan structure, the steps undoubtedly seemed many and long.

If it had occurred to Eaton to scrape off the active material from his plate, leaving the holes full, he would have hit upon the invention. But he never did. If Brush had thought of punching out the bottom of his receptacles, and had then rammed them full of active material without covering the external plate, he would be entitled to the credit of having made the successful structure. But he did not think of it. The experiments at that time seemed to be proceeding along different lines, the object being to keep as much material as possible upon the surface of the plate.

The conviction cannot be avoided that the idea which has made these plates a commercial success, was first given to the world in a practical embodiment by Mr. Swan.

Confirmation of these views is found in two recent decisions of the Supreme Court. In Washburn & Moen Company *v.* Barbed Wire Company (decided February 29th, 1892) the court says:

"The difference between the Kelly fence and the Glidden fence is not a radical one, but, slight as it may seem to be, it was apparently this which made the barbed wire fence a practical and commercial success. The inventions of Hunt and Smith appear to be scarcely more than tentative, and never to have gone into general use.

"The sales of the Kelly patent never seem to have exceeded 3,000 tons per annum, while plaintiff's manufacture and sales of the Glidden device (substituting a sharp barb for a blunt one) rose rapidly from 50 tons in 1874 to 44,000 tons in 1886, while those of its licensees in 1887 reached the enormous amount of 173,000 tons. . . . Under such circumstances courts have not been reluctant to sustain a patent to the man who has taken the final step which has turned a failure into a success. In the law of patents it is the last step that wins. It may be strange that, considering the important results obtained by Kelly in his patent, it did not occur to him to substitute a coiled wire in place of the diamond-shape prong, but evidently it did not and to the man who did ought not to be denied the quality of an inventor."

In Magowan *v.* New York Belting Company, 141 U. S., 332, it was held that the fact that the patented improvement "went at once into such an extensive public use as almost to supersede all packings made under other methods . . . . was pregnant evidence of its novelty, value, and usefulness."

These quotations seem peculiarly applicable to the present controversy. The principles which are there so clearly and pointedly reaffirmed require a decision sustaining the validity of the complainant's patent.

As to defendant's infringement there can be no doubt.

The question arising upon the expiration of the Danish patent has not been argued. The casual examination which the court, in the absence of examination, has been able to give to this patent leads to the conclusion that it is not for the same invention as the Swan re-issue.

There should be a decree for the complainant.

Mr. William Bracken, President of the Consolidated Electric Storage Company, exclusive licensee of the Brush patents, has sent us the following comments on some of the published statements regarding the scope of this decision:—

"The newspapers in the last few days have been made the vehicle for conveying to the public the idea that Judge Coxe, of the United States Circuit Court for the Southern District of New York, had, in the case of the Accumulator Company against the New York and Harlem Railroad Company, awarded to one J. W. Swan, and his assignees, the sole and exclusive right to a perforated support plate for storage batteries; that without such a plate Swan claims no practical storage battery had ever been made, and that this decision postpones indefinitely the use of storage battery cars and the like. An examination of the decision itself will show how misleading are these statements.

"Swan was not the inventor of the perforated plate. On the contrary, Judge Coxe took that claim away from him in the case of the Electrical Accumulator Company *v.* Julien, and gave the broad claim to Brush in the case of the Brush Electric Company against the Electric Accumulator Company. Neither has Swan the right to put active material in the perforations or apply it in any way to a perforated plate, for that has been awarded to Brush.

"His claim is the narrow one of putting the active material in the perforations *only*. His claim does not cover the method of putting the active material in the perforations and at the same time spreading it over the surface of the plate. Neither does it cover the putting the active material in any manner in grooves, receptacles or perforations that do not extend wholly through the plate. The progress of the storage battery industry will not be retarded one hour by the decision."

Telephones in France. — Telephonic communication between Paris and Bordeaux is at present being established. A second telephone line from Bordeaux to Pauillac is being erected. It is proposed to erect telephonic exchanges in the towns of Pau and Libourne. Telephonic communication has been possible since the commencement of April between Paris and the following towns:—Amiens, Arras, Châlons, Reims, Epernay, Marseilles, Aix, Nantes, Orleans, Saint Quentin, Tours, Troyes, Lille, Lyons, and Rouen.

ELECTRIC TRACTION AT BRADFORD.

ON Monday last a party of gentlemen met in the town of Bradford to witness the running of an electric tramcar. The demonstration was the result of arrangements made by the Bradford Corporation with Messrs. Easton and Anderson. We believe the terms of the agreement were that £500 should be devoted to carry out experiments lasting over several weeks. If at the end of this term the municipal authorities were satisfied with the results of the running, they would buy the car, with motors, switches, &c., complete. For the purpose of the experimental run the Corporation selected a stretch of a quarter of a mile on the most difficult section of the tram lines, over which usually run the steam trams. Save for a few yards the track is a hill with an average gradient of 1 in 14, and includes a sharp curve. Temporary overhead wires were erected, for the most part being slung to the buildings on each side of the roadway. The current was obtained from the corporation electric lighting station. Two small 300 volt Siemens dynamos connected in parallel were employed. The car used was one specially built, 9 or 10 feet long, of a carrying capacity of 36 passengers. Two double armature motors with worm gearing were used. The experiments throughout have been carried out under the personal direction of Mr. Holroyd Smith.

There can be no question of the success of the experiment so far as the actual running up the hill is concerned, but, of course, there must be coupled with this success the cost of driving the car. With a full complement of passengers, 45 ampères at 300 volts has been found necessary, but on one occasion, on Monday, when the car carried 43 adult passengers, seven more than the usual number, 70 ampères, or nearly 30 horse-power, was required for the greater part of the journey. It is, perhaps, to be regretted that the experimental course did not include a level section of the line; in fact, it seems to us that if the electric car has been tried for the purpose of ascertaining the cost of climbing the hill, a somewhat unfair test has been made. It may be that the only question at issue was the ability of the electric car to get up a steep hill. In any case, a run which included a level track would have been far more satisfactory, for one might then have arrived at some determination regarding the performance of this particular car. Strict comparisons might not have been possible, but at any rate some rough idea of the capabilities of the car would have been gained. On the journey down the hill the control of the car seemed absolute. It was shown by a sudden removal of the trolley from the conductors that the tram suddenly stopped. This was no doubt due to the motor for the moment acting as a generator, and the action of this current would tend to force the car in the opposite direction to the one in which it was travelling, thus causing a sudden stop. As an experiment, no doubt, this was of great interest, but such a method of stopping the car would neither be wise nor generally useful, except on an emergency.

The demonstration which has taken place at Bradford is full of significance, for it showed some of the conditions which electric traction will have to meet in England.

To run electric cars over a straight bit of road on the overhead system may not present insurmountable obstacles, but in a scheme to run electric tram cars through crooked thoroughfares, up hills of heavy gradients, and round sharp corners, grave problems will be met. It is an open question how far American practice and experience will assist in overcoming the difficulties peculiar to English towns. The abolition of the steam car from the streets of Bradford, Huddersfield, Batley, Dewsbury, and other towns, would no doubt be of immense importance; but when one considers that in Huddersfield there are long hilly streets which have sometimes three and four cars on at the same moment, the sudden demand for extra horse-power would be so great that plant of considerable dimensions would be necessary to meet the demand.

The Bradford experiments have been carried out under the best conditions, everyone being anxious to make the matter a success. Shopkeepers and householders have willingly given consent for the fixing of supporting wires on to the houses, thus facilitating matters much. We believe, however, that the overhead wires are voted by many to be an eyesore. This is scarcely understood when one considers that steam trams have long been tolerated, and that streets are, in the first place, supposed to be subservient to traffic.

THE BRITISH INSULATED WIRE COMPANY.

Within the last few months the foundation has been quietly laid of an undertaking which is likely to prove a factor of some importance in the development of the electrical industry during future years. Although in America paper insulation has been very widely adopted, and, in fact, for telephone purposes is preferred to any other, the system has not as yet been dealt with in this country, except experimentally. The introduction into Europe of the manufacture of paper-insulated wires and cables, is due to Mr. James B. Atherton, a director of the Norwich Insulated Wire Company, of New York. The British Insulated Wire Company was formed in 1890 for the purpose of acquiring the patents for Great Britain, and a site for works was secured close to Prescot Station, about eight miles from Liverpool, on the London and North Western Railway, with which there is a connection by a siding.

In August last the company acquired the patent for the manufacture of electrical mains and conductors, taken out by Mr. S. Z. de Ferranti, and on the completion of the purchase, Mr. Ferranti joined the board of directors, the other members being Mr. Marriner Brigg (chairman), Mr. James B. Atherton (managing director), Mr. E. K. Muspratt, Mr. Thomas Priestly, Mr. John E. Pearson, and Sir David Radcliffe.

The buildings at Prescot are of considerable extent, and are erected in the style of a weaving shed with ridged skylights, so as to utilise to the utmost the light of day. The whole arrangement of the factory and machinery has been well thought out, so as to economise time and labour as far as possible. The front block of the building contains a large board room and lofty, well-lighted offices for the managing director, the secretary, the engineer, clerks, book-keepers, type-writers, and others. Behind this is the principal room of the factory, covering a space of 140 feet by 80 feet, which is so arranged that the raw material is delivered off the railway siding at the near end of the north side of the works, and is passed on from point to point for the several necessary operations till it reaches the opposite end of the room. It there enters the drying, compounding, and lead-covering departments, ultimately emerging in the finished state at the far end of the north side of the factory, where it is either delivered direct on to the railway waggons alongside or consigned to the stock room.

The peculiarity of the company's insulation consists in the use of paper as a medium for absorption of the insulating compound. The following are the main points to be considered in insulated electrical conductors, all of which will be found to be complied with in these cables :—1. The insulation should fit the wire closely and elastically. 2. It should come off easily, so as not to cause the conductor to be cut or scraped in cleaning. 3. It should leave a thin film on the surface sufficient to prevent the deposit of moisture from the air on handling. 4. It should be clean, not gummy or sticky. 5. It should be positively cylindrical and uniform in size.

The construction of the company's cable is a mechanical one, being built up layer upon layer with a prepared insulation. The result is that the insulation does not depend simply upon one strata, but has the benefit of solidity, and at the same time of numerous thicknesses of the material, which help one another. Both for mechanical and electrical reasons, the company lead sheath the insulation, not necessarily as a waterproofing, but as a mechanical protection which will defend the core from damage. Of course, at the same time, the lead sheathing performs the function of a waterproof covering, but lengths of core have been tested in water at different temperatures and pressures, and there has yet to be found any absorption by the core of moisture. A further advantage of the lead sheathing is that it tends to consolidate the insulation when the cable is being wound off or on to a drum, or is being drawn round the corners in a pipe line or conduit.

The finished cable shows a high insulation, and although the company are well aware that a high insulation *per se* is no criterion of goodness, a high insulation, *ceteris paribus*, is a great advantage if its value can be maintained, as in this case.

As to insulating for various tensions, it has been found that a thickness of a millimetre gives way under a stress of 10,000 volts. It will be noticed that the material used by the company is therefore quite as good as rubber in its ultimate strength to resist disruptive discharges. Therefore, in designing cables, the mechanical conditions are more important than the electrical ones, and the cables for low tension have in practice a very large factor of safety, which secures them from mechanical damage, while those which are intended for medium tensions, or, say, from 500 to 1,000 volts, being usually lighter in conductors, have a still greater margin of safety. The cables of the company are much used for extra high pressure work, and this is a branch of business to which the company both in this country and in America has devoted very great attention. Several instances of cables working under a high pressure, both in this country and the States, have proved in practice what has all along been argued in theory. Tests on various cables have shown the insulation to go up to 15,000 megohms per mile.

Plant has been laid down for turning out wires and cables of all diameters on the most extensive scale. Much of the machinery has been made by Messrs. Prince Smith & Son, Keighley, whose work, it is satisfactory to learn, is found far superior to that expended upon American machines, made and supplied for similar operations. The driving power is supplied by a Marshall coupled compound engine of 200 H.P., and is taken off by ropes to the different lengths of shafting.

The insulating paper reaches the factory in reels of the full mill width, and is cut into tapes by machines which automatically divide the paper into strips, and wind it into reels ready for use. There are other machines ingeniously designed for different processes, but the most interesting of all is the hydraulic lead covering machine, from which the cables come out shining like silver. Machines for this purpose have hitherto, we believe, delivered the cable vertically, but the machine here works horizontally, and therefore much more conveniently for the attendants. The cable enters the apparatus at one side where a die receives it, and also the molten metal which is pressed evenly on the cable as it moves through the machine and out at the opposite side on to the drum. Any length can be covered without a join, and the thickness of the coating can be regulated by the die. In America the drums upon which the cable is reeled are made much larger, but the railway system in this country necessitates limiting the diameter to 8 feet 6 inches.

For testing purposes the company has got together, at great cost, a set of instruments and experimental apparatus such as is seldom, if ever, seen in a manufactory of this kind, a testing set supplied by Messrs. Nalder being one of the finest ever made.

The whole of the works and offices are well lighted electrically, the installation having been carried out by the company's own workmen, with conductors and fittings made on the premises.

The secretary to the company is Mr. Jacob Atherton, the engineer Mr. Chas. H. Yeaman, formerly electrician to the corporation of Liverpool, and the works manager Mr. Henty, late with Mr. Ferranti at Deptford.

HARTMANN AND BRAUN'S RECORDING VOLTMETERS AND AMMETERS.

These recording voltmeters and ammeters are designed for the purpose of permanently recording the pressure, or quantity of current passing through a circuit at any given moment.

1. They consist of a sensitive dead beat voltmeter, which actuates the recording pen.

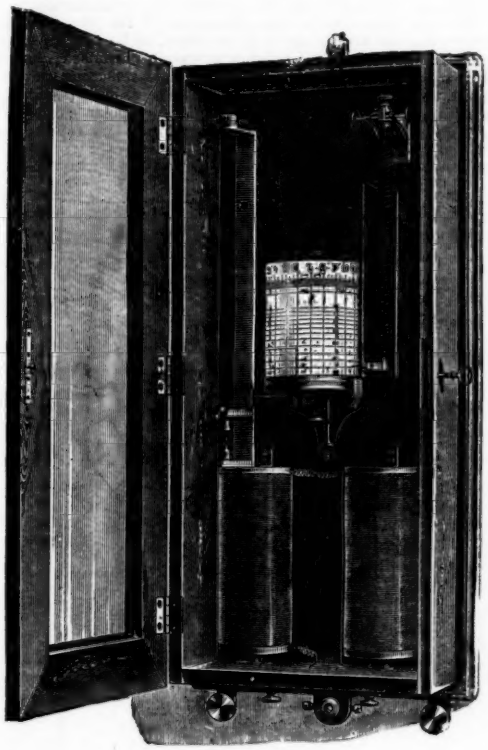
2. The drum for holding the paper is rotated by clockwork at any speed required. The measuring instruments are designed on the Kohlrausch system, and consist of a solenoid, which, when the current passes, sucks in a soft iron core on which is fixed the recording pen, a torsionless spring serving as counterforce.

The core is connected at its point of suspension to a lever, to enable the pen to be adjusted to touch against the paper as lightly as possible, as, should the pen press heavily

against the paper, it would affect the accuracy of the readings.

The recording pen must be filled with good registering (aniline) ink, and should be occasionally cleaned, for which purpose the nut must be unscrewed and the pen removed, then soaked in spirit, and brushed with a camel hair or other soft brush.

The drum carries the recording paper; when it is desired to insert a fresh sheet a nut is removed, and the drum lifted off.



The recording paper is graduated in hours, the dark figures representing the night time, and the light ones the daytime; it is gummed, and should be put quite smoothly round the drum and then fixed, the paper carrying the record should be cut apart at the point where the record commences.

A glass scale to determine the value of the recorded curve is furnished with each instrument, the scale is graduated for either volts or ampères, and when the top graduation thereon is placed over the top line on which the hours are printed on the paper, the curve can be read off direct in volts or ampères. Instructions for fixing and working:—

The instrument must be fixed on the switchboard in a perfectly level position, as shown by the level. The cover is then removed, and the pen shifted away from the drum.

The nut is unscrewed, and the drum lifted off.

The clockwork is then wound up by pushing a lever to and fro, and should the clockwork not start when wound up, a pull on a little pin which projects from underneath the drum by the side of the lever will start it.

After removing the paper on which a record has been made, a new one should be put on and gummed down; the drum is now replaced and turned round until the point of the pen coincides with the correct hour line; the nut is screwed down, the pen is brought in contact with the paper, and the cap replaced. The instrument is now ready.

The connections to the circuit are the same as for any ordinary ampère or voltmeter.

Cycles and Telegraphs.—The telegraph messengers at Tours, Dijon and Lille, in France, are now provided with "Safety" bicycles to ensure a prompter delivery of the telegraphic messages.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

NOTES ON THE LIGHT OF THE ELECTRIC ARC. By ALEXANDER PELHAM TROTTER, B.A., Member. Paper read April 28th, 1892.

It is apparent to intelligent observers, and well known to all electric light engineers, that the light of an arc lamp is not emitted uniformly in all directions. Photometrical measurements of arcs are generally expressed by a polar curve, the length of the radius vector representing the candle-power. Although a good deal of work has been spent on this subject, the real meaning of the shape of these curves has not attracted much attention. They all exhibit the same characteristics, and it is easy to notice two distinct types of variation. One variation is found with arcs employing a large current, and consists in the emission of a small quantity of light in a direction above the horizon, the curve rising a little above the horizontal axis. Another type of variation is the narrowing of the whole curve, and the concentration of a large proportion of the light at an angle of about 40° or 50° with the vertical.

A rather complicated treatment of the subject has been made by M. Rousseau* with the object of finding a formula for the distribution of the light. His treatment seems to be empirical, and, having arrived at a formula, he does not appear to have recognised the practical meaning which it contains.

It has been assumed by many persons that the hollowing of the crater of the positive carbon tends in some unexplained manner to concentrate and throw the light downwards. It is evident that the lower, or negative, carbon intercepts a good deal of the light; but there speculation appears to have stopped. A little consideration will show that the effect is precisely and identically the same as though the end of the positive carbon was flat. No tilting of an incandescent or other luminous surface can make it brighter; and, on the other hand, if it is covered with a thin, imperfectly transparent layer, as in the case of the atmosphere of the sun, the edge will appear less bright than the middle of the disc. The quantity of light emitted by an incandescent disc in any direction is proportional to the amount of surface visible from that direction. That is to say, candle-power varies, then, as the cosine of the inclination.

Cosines plotted as a polar curve give a circle passing through the pole. This theorem is not to be found in mathematical works, being much too easy and simple for those students who have got so far as polar curves. The candle-power of the crater of an arc lamp should, then, if plotted as a polar curve, coincide with part of a circle. Any deviation from the circle must have some cause. Two such deviations are observed, and their causes are easily recognised.

An ideal continuous-current arc—in fact, any good one with first-rate carbons—has a uniform horizontal crater, and this gives no light in a horizontal direction, though a little may come from the hot sides of the carbon, especially if it is carrying a rather large current. No brightly incandescent surface is seen. The pointed negative carbon is seen in profile, and some light is emitted by it. From what Professor S. P. Thompson and others have told us of the physics of the arc, it is very probable that the seat of the dissipation of energy is primarily at the surface of the crater. The negative carbon only becomes hot by being cooked in front of the crater. It is wasted, probably, by mere combustion; and even this waste is reduced by the deposition, under some circumstances, of carbon transferred from the positive pole. The waste of the positive carbon is undoubtedly due to volatilisation. Professor J. J. Thomson and others have shown that electrolysis is not necessarily confined to bodies in the liquid state, and it seems probable that the volatilisation of carbon at the crater, and its deposition, under certain conditions, on the negative carbon, is closely allied to electrolysis, the positive pole behaving as an anode, both in its wasting and in the fall of volts at its surface. The absorption of energy appears to be twofold. A certain quantity of heat is required to produce the change of state from solid to vapour, and a certain difference of potential must be required to produce the electrolysis.

In one of the very interesting articles by M. Palaz† in which he abstracts and compiles the work of numerous Continental writers, he states, without giving his authority, that 85 per cent. of the light of an arc is emitted by the positive carbon, 10 per cent. by the negative carbon, and 5 per cent. by the flame of the arc. It seems probable that in most cases the proportion of light emitted by the positive carbon is even greater than this. The word "arc" will be used in this paper as an abbreviation for arc lamp, and will not be used to denote the flame which plays between the carbons. The word "crater" will be used to denote that portion of the positive carbon which is at the highest degree of incandescence. This portion is generally well defined, the colour being uniform. The word "crater" will not be used to signify a hollowing of the carbon.

During the Antwerp Exhibition in 1885, M Wybauw‡ made a number of photometric measurements of arcs by different makers. The full curve in fig. 1 represents the mean of a large number of observations made, no less than 26 different arcs having been tested. The cosine of 60° being one-half, the area of the crater seen from this direction is one-half of that of the full circle; the candle-power is one-half of that emitted by the crater; and the length of the radius vector corresponding to 60° may be taken as the radius of the circle. The light due to the negative carbon is clearly shown as an excess above the circular curve; there is, indeed, nothing else to which it can be due, except the red-hot walls of the crater.

At about 60° the curve of candle-power begins to fall off, and this is due to nothing else than the shadow of the lower carbon, which

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* *La Lumière Electrique*, Vol. xxxvii., p. 415.
† *La Lumière Electrique*, Vol. xxxvii., p. 410.
‡ *La Lumière Electrique*, Vol. xxxvii., p. 414, and Vol. xxvi., p. 58.

intercepts more and more of the light as we pass to smaller angles, until, if the carbons be of the same diameter, no light is thrown in a vertical direction.

In considering the real meaning of the latter part of the curve, the author drew a number of views of a pair of imaginary carbons, projected at different angles. The elliptical area of the crater in each view was calculated, and he found that these areas, plotted as radii of a polar curve, gave a curve closely resembling the well-known candle-power curve of the arc. It follows that, if this be proved to be true by experiment, the candle-power per square millimetre of the crater is constant.

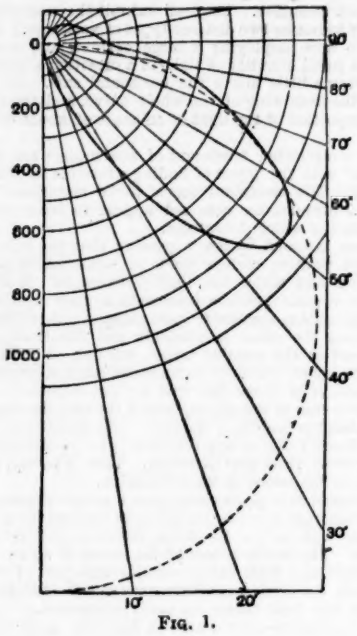


FIG. 1.

The author communicated this result to Prof. S. P. Thompson, and asked if he would see whether actual experiment would confirm it.

A series of very interesting experiments have been carried out at Finsbury Technical College by Mr. C. F. Higgins, senior student. A "Planet" lamp, taking 8 or 9 ampères, was first employed, and the first experiments showed that the light was undoubtedly proportional to the area of the crater. In order to carry out the experiments with greater accuracy, a larger lamp was required, and Messrs. Johnson and Phillips kindly lent a Brockie-Pell lamp, taking 25 ampères. The following apparatus (fig. 2) was constructed by Mr. Higgins at the

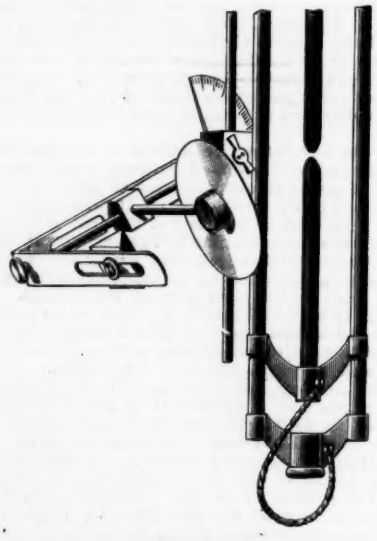


FIG. 2.

workshops of Finsbury College, for the purpose of projecting an image of the arc:—

An arm adjustable on a horizontal axis, and provided with a clamping nut and graduated arc, carries a lens and a mirror set at an angle of 45 degrees, with the direction of the ray of light falling on it, and reflecting the ray in a direction parallel with the axis of the radial arm. An image of the arc may thus be projected on a screen. As the radial arm is moved the image turns round, but this does not interfere with the observations. An Ayrton-Perry photometer, slightly modified, was used to measure the light with a standard candle, and this was done by removing the projecting lens, and allowing the reflected beam to fall on the mirror of the photometer. When the lens was replaced, for the purpose of projecting the image, the mirror of the photometer was removed, the rest of the photometer remaining undisturbed. The image was received on a sheet of drawing paper, and was amplified about 14 times. The outline of the incandescent crater was traced in pencil, and in some cases an outline of the carbons was drawn. The diameter of the carbons formed a standard for absolute measurements. Readings were taken at every 10° inclination. The area of the tracings was measured by a planimeter.

In the first experiments the absorption of the two mirrors was neglected, and the results are not, therefore, to be taken as candle-power. The mirror on the radial arm was of platinised glass, since an ordinary mirror gave a double image. The reflecting power was not good, though the image was clear. The areas were also measured to an arbitrary scale at first. Figs. 3 and 4 give polar curves of two sets of observations. The photometer readings are represented by

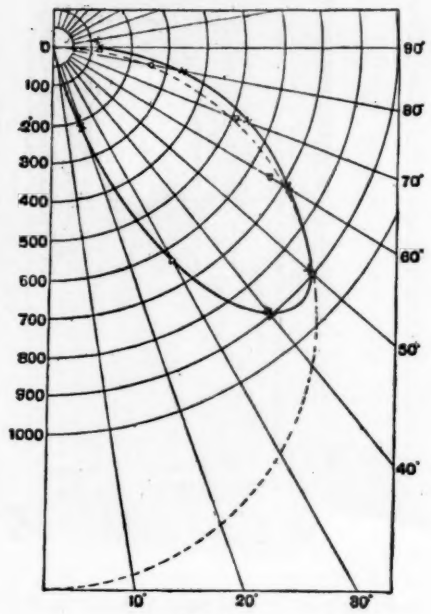
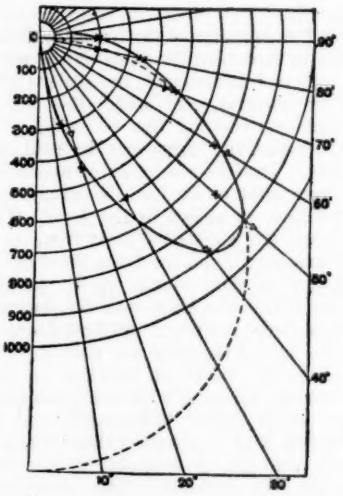


FIG. 3.



△ = area, and × = candle-power. The scale of radii is arbitrary.

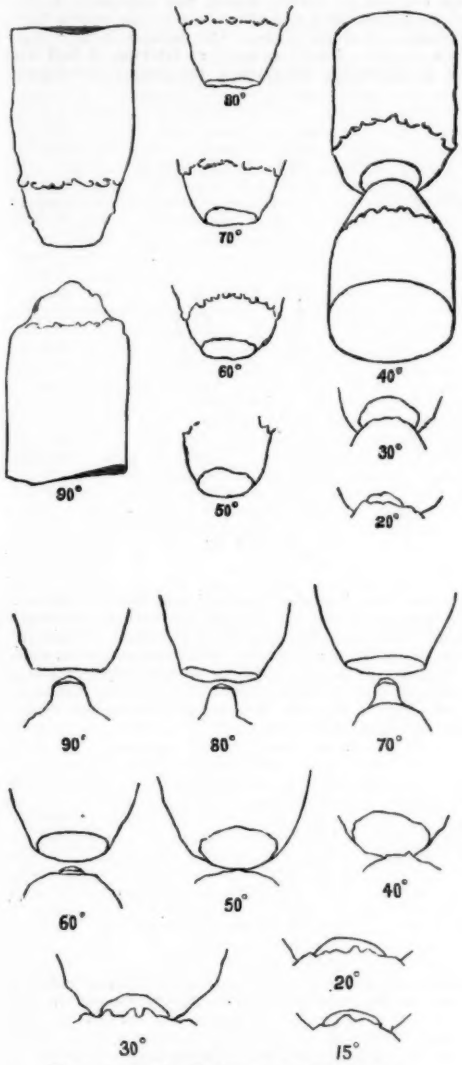
FIG. 3. FIG. 4.

CURVE OF AREAS OF CRATER AND CANDLE-POWER OF SHORT ARC.

circles, and the areas by triangles. A general coincidence of both sets of observations with the well-known curve is evident. Figs. 5 and 6 are reproductions of the tracings.

It is rather difficult in many cases to estimate the relation between two polar curves by mere inspection, partly perhaps because they are

so seldom used in practice. Two different curves may be drawn, the one through the photometer readings, and the other through the areas of crater; but, owing to the difficulty of arriving at accurate results, on account of changes in the length of the arc, which greatly affect the inner part of the polar curve, and the occasional indistinctness of outline of the crater, the errors of either set of readings are probably as great as their departure from the curve drawn freely among the two sets.



FIGS. 5 AND 6.—TRACINGS OF SHORT ARC.

Useful as it is to plot as a polar curve observations which relate to measurements taken at different angular directions, the relation between the two sets of readings may be examined more easily when they are plotted with rectangular co-ordinates (fig. 7). A straight line cutting the axis at 100 C.P. seems to fit the results. This may be explained by the light which is emitted by the red-hot and glowing parts of the carbon. These were not included in the measurement of area; the true crater only was measured. The author has been unable to carry out any complete experiments on the photometry of arcs; the present paper is only a collection of notes on the subject, which is treated qualitatively and not quantitatively. The measurements, for various reasons, were relative, and attempts were made on one occasion only to take direct readings in candle-power. The image of the crater at 60° was projected and traced, and measured by a planimeter. The mean of several fairly concordant readings was 20·8 square inches. The diameter of the image of the carbon was 17 inches. Its actual diameter was 0·6 inch. The image was therefore magnified 28·3 times. The real area of the crater was 0·025 square inch. The candle-power readings were taken at the same angle, and immediately after the tracing of the image in each case, being measured directly from the arc without reflection. They were fairly concordant, and gave a mean of 1,065 candles. At the maximum position (about 45°) this would give about 1,400 candles. It follows, therefore, that the crater gave 42,600 C.P. per square inch, or 64 C.P. per square millimetre. The ampères were 26, and volts 51.

It is as impossible to raise carbon above the degree of incandescence of the crater of the arc as it is to raise water above boiling point or ice above melting point.* No substance has yet been suggested for "improving" arc lamp carbons which is less volatile than carbon. Even the core of cored carbons, while it serves a very useful purpose in steadying the arc, is less brilliant than the rest of the crater. If a lower temperature than the normal incandescence be found at the crater, it is because the positive carbon is too large for the current. Under these circumstances the arc generally flickers irregularly, and a highly incandescent patch travels about over the surface of the crater.

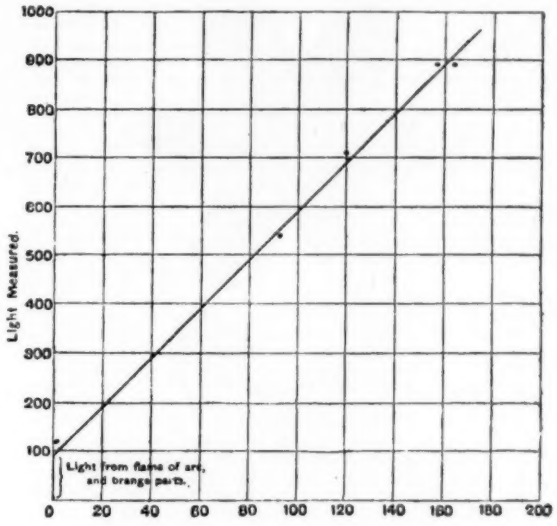


FIG. 7.

The large amount of light intercepted by the negative carbon raises the question, What becomes of it? It is evident that it strikes the lower carbon, and is probably converted into heat; but since only about 10 per cent. of the whole radiation of an arc is in the form of light,† most of the "cooking" of the lower carbon is done by mere heat.

It is not difficult to reconstruct the shape of the carbons which must have given rise to the curve given in fig. 1, but to do so is nothing more than a geometrical exercise, and leads to no useful result. A similar relation obtains between the candle-power curve of an alternating current arc and the shape of its carbons, but the use of alternating arcs is not common: the light is not, for outdoor purposes, thrown in a useful direction; it is difficult to prevent the arc from flickering round the carbons, and they give so much trouble from other causes that they are seldom worth using.

Two other kinds of arc are the lighthouse and the search light. A very elaborate set of experiments was carried out in 1878 at Chatham, under the direction of the Royal Engineers Committee, by Major R. Y. Armstrong, Lieutenaut G. Bowker, Lieutenant P. Cardew, Lieutenant L. Darwin, Lieutenant G. A. Carr, assisted by Lieutenant R. White and Captain Abney. Ten dynamos, six lamps, six projectors, and five kinds of carbons were tested; photometric measurements were made, and photographs were taken both facing the crater and at right angles to it. From the photographs the area of the crater could be determined. The candle-power per square inch seemed to vary in an indefinite way between 76,000 and 25,000 candles per square inch.

The photographs taken from the side give a very good idea of the position of the carbons and the small obstruction of the negative carbon when a search light is properly arranged. Finding that so complete an examination of search lights has been made, the author has not proceeded with the experiments which he had intended to carry out on this kind of lamp. He had some difficulty in finding this report, which was intended for Government use only. He was allowed by Major R. Ruck to examine a copy at the Horse Guards, and on making application through him to the Inspector-General of Fortifications the report was allowed to be made public. Instead of attempting to abstract this very interesting research, the author has presented the copy to the Library of the Institution.

By permission of Mr. Inglis, secretary to the Trinity House, the author was allowed to examine the working of the St. Catherine's Point Lighthouse at the beginning of the present month, and to have the machinery run during the daytime. The magneto machines and lamps are the same that were used at the South Foreland in 1884 and 1885. Alternating currents from 180 to 300 ampères are used; the volts at the lamp are only about 35 to 38. Sir James Douglass's fluted carbons, of 50 mm. and 60 mm. diameter, are used, the smaller size being employed during clear weather. Fig. 8 gives sections of these carbons full size; they have a graphite core. The conditions are altogether different from the continuous current arc which has been described. It was found during the South Foreland

* S. P. Thompson, Society of Arts, March 6th, 1889, *The Electrician*, Vol. xxii., p. 534.

† Prof. Marks, American Inst. Electrical Engineers, Vol. vi.; *The Electrician*, Vol. xxv., p. 150, *et seq.*

experiments that a short arc gives more light than a long one. It must be remembered that the horizontal light is the most useful, although in a large lantern a considerable angle is utilised by the lenses. A large alternate current arc is very unsteady: the flame burns away the carbon in a very irregular manner; and when round carbons were used a hollow crater was formed at the end of each. The walls of the crater would give way, and cause great variation in the light. By the use of fluted carbons little, if any, hollowing takes

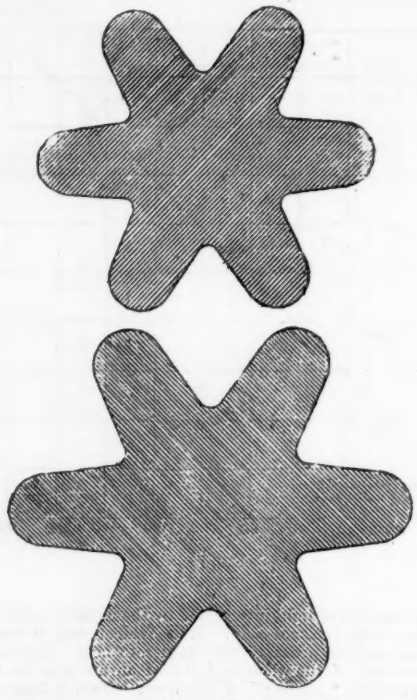


Fig. 8.—Section of Sir James Douglass's Fluted Carbons, 50 mm. and 60 mm.

place, and the light is uniformly emitted. It seems probable that, since each carbon is only at a high state of incandescence during half a period, a short arc gives more light because the carbons keep each other warm. The same amount of radiant energy may be given off

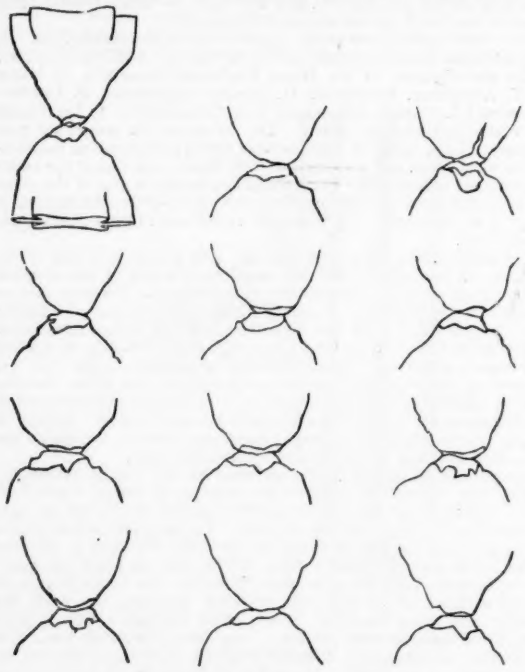


Fig 9.

with a long arc and a short one, but when the chilling of the negative is reduced a greater proportion of the radiation will be in the form of light. With a long alternating arc the flame wanders round, and is blown violently sideways, and the crater therefore tends to be shifted to one side of the carbon. The distance between the carbons is only $\frac{1}{10}$th inch to $\frac{1}{4}$th inch, and as they are by no means flat it is the exception that any interval can be seen between them.

The author understood that an optical apparatus was provided for projecting the image of the arc on the side of the lantern, for the purpose of keeping the carbon points in the focal plane of the lenses. He found no such instrument was in use at St. Catherine's Point, but a very satisfactory image was thrown by the object glass of a telescope. The distances were arranged so that the image was full size. The shape changed so quickly that it was impossible to draw the image with great accuracy, and attention was paid only to the outline of the carbons and of the crater. The outlines in fig. 9 are reproduced from a series of tracings made at intervals of half a minute. Fig. 10 is an interesting set, showing the gradual development and

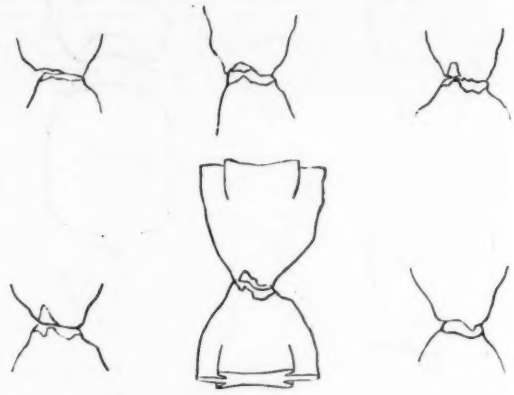


Fig. 10.

disappearance of an irregular interlocking of the two carbons. This does not appear to have any connection with the flutings of the carbons, and the author has noticed it on several occasions, both at the lighthouse at the recent Naval Exhibition and at St. Catherine's Point. A glance at these tracings shows that only a very small portion of the true light-giving surface is visible, owing to the shortness of the arc. Fig. 11 is a pair of tracings showing the most regular and the most irregular form of crater.

Fig. 11.

The areas of the crater on the tracings were measured by a planimeter, the tracing point being taken ten times round. The mean area of fig. 9 is 0·2087 square inch, and the mean of fig. 10 is 0·146 square inch. The interlocking form of crater appears, therefore, to give about 30 per cent. less light. The candle-power for 240 ampères, according to the measurements made at the South Foreland in 1884 and 1885, is about 16,000 C.P., giving about 75,000 candles per square inch if the light were entirely due to the crater. The area of the yellow and orange coloured parts of the carbons was very difficult to estimate, but it was very much greater in proportion to the true crater than in a continuous current lamp taking 10 to 20 ampères. Taking these parts as exposing about four times the area of the crater, and giving $\frac{1}{3}$th of the light per square inch, the crater alone may be taken as giving two thirds of the whole, or about 50,000 candles to the square inch. This agrees fairly well with the result already given for the measurements at Finsbury.

It was found during the South Foreland experiment that 40 mm. cylindrical carbons became red hot throughout their whole length when 300 ampères were passing. The fluted carbons, measuring 60 mm. over, have a sectional area equal to that of a cylinder about 46 mm. diameter—that is, $2\frac{1}{2}$ square inches; but the cooling surface is about 50 per cent. greater. Larger carbons would probably burn yet more irregularly, and yet it seems very desirable to increase the light during foggy weather. If the ends of the carbons could be maintained conical, all the light-giving surface would be usefully employed. A carbon which is more and more refractory towards the centre suggests itself; but even at present the consumption is from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches per hour, and modification can only be made in the direction of less refractory material. The flame might be made to spin round the carbons under the influence of a magnetic field; but the simplest plan seems to be the revolution, or gyration, of the carbons about a common axis, their centres being slightly displaced. In order to obviate sliding contacts, a gyratory motion would be the best. The power of the St. Catherine's Point Lighthouse has been called 6,000,000 to 7,000,000 C.P. This would require an area of crater of about 1 square foot.

(To be continued.)

LIGHTHOUSE ILLUMINATION AND THE ELECTRIC LIGHT.

In the recent paper read by Mr. J. R. Wigham on "The Giant Lighthouse Lens," the oft repeated condemnation of the electric light for lighthouse illumination was once more emphasised. "The great interest," said Mr. Wigham, "which attaches to this lens at the present time is that its appearing now is most opportune because of the dissatisfaction of the French lighthouse authorities with the performance of the electric light as a lighthouse illuminant. The electric light has been applied at some of their lighthouses for many years, and they had intended to apply it to many more of their lighthouses, but the complaints which have reached them have induced them to alter their determination. Hence the engineers of the French Lighthouse Department are naturally looking for a substitute, and it is for this reason that this new lens has excited so much interest in Paris. We are, of course, all aware that the electric arc light is by far the most intense artificial light which has ever been used for lighthouse purposes. I have experimented much with it. In clear weather its power is enormous. I have read the *Times* newspaper at Salthill by the electric beam directed from the experiment house at Howth Baily, but I found, as has since been also found in actual practice by seamen and others, that, as the weather became foggy, this enormous light diminished far more rapidly than did the light of an ordinary oil or gas lamp, and that these latter lights remained visible after the electric light had been entirely extinguished by the fog. The Shipmasters' Society, in a letter to the Trinity House, dated March 7th, 1891, says:—'Many members of this society on active service frequently passing from the Thames to sea, and *vice versa*, have often represented the poorness, sometimes invisibility, of the electric lights during certain conditions of hazy atmosphere, at times when the oil lights of lightships, &c., and the gas lights of seaside towns have been comparatively bright and distinct.' They continue: 'Again, complaints have been made of the intense and blinding effects produced on navigators by electric lights such as the South Foreland on vessels in its immediate vicinity.' The reports from the United States of America are also unfavourable to the electric light as a lighthouse illuminant, and show that its use has been actually given up in the States. The New York *Electrical Review* says that 'the lighthouse officials have given up the idea of using electric lights in lighthouses. The electric light, which was established for the purpose of testing its adaptability to the service, proved so unsatisfactory to navigators, and brought such earnest protests from shippers that it was abandoned.' Thus it would seem that the electric light as a lighthouse illuminant is unsatisfactory to British seamen, that in France its progress has been arrested, and that in the United States of America its use has been absolutely abandoned. The lens at which we are looking may be regarded as the furthest development, on a practical scale, of the principle of quantity or volume in contradistinction to intensity in the light used for lighthouse purposes. The electric light, the highest example of intensity, has put forth its greatest effort at St. Catherine's Point, Isle of Wight; its six or seven millions of candles have there had full play, with what effect the nautical portion of the community, in view of the stranding of the *Eider* and the correspondence which has arisen theron, are now seriously considering. This new lens and its large gas burner will enable the advocates of volume to show in their turn what they can do. The maritime public are watching the struggle with much interest; human lives are involved in the issue. The electric light has, indeed, been fully tried and found wanting, but the other side has not yet been fully tried. It remains yet to be seen what the full power of gas flames shining through lenses suited to their size and power can do to fill the place which it was fondly hoped the electric light would occupy."

LONDON COUNTY COUNCIL.

The following matters were brought up by the Highways Committee at the meeting preceding the Easter adjournment.

Electric Lighting—Applications for Provisional Orders.

The Board of Trade has forwarded for the council's observations a copy of the electric lighting order applied for by the Vestry of Lambeth, in the form in which the Board proposes to issue it. We have carefully examined the order, and the only amendments, which appear to us to be necessary, are the insertion of the name of the council in clause 8, relative to the placing of overhead wires, and that it should be made perfectly clear that Vauxhall, Lambeth, Westminster, and Waterloo bridges are exempted from the operation of the order. We recommend that the Board of Trade be informed that, subject to the amendments above referred to, the council approves of the form in which the Board proposes to issue the order applied for by the Vestry of Lambeth.

Notices under Electric Lighting Acts and Orders.

We have considered a notice dated March 26th, 1892, from the Electric Supply Corporation, of intention to lay distributing mains in St. Thomas Street, Crucifix Lane, and Artillery Street. These mains will consist of concentric covered cables drawn into iron pipes, and similar works have been approved by the previous notices of this company. We recommend that the sanction of the council be given to the works referred to in the notice dated March 26th, 1892, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be laid under the footways, and be kept nine inches below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; that the positions of the street boxes, and the mode of construction of them, shall be submitted to and approved by the council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering.

Mr. H. Robinson has, on behalf of the vestry of St. Pancras, given a notice, dated April 4th, 1892, of intention to lay mains in Seymour Street and Drummond Street, Gee Street, Clarendon Square, and Hampden Street. The council has already approved of the manner of laying electric light mains adopted by the vestry, and there appears to be no objection to the works now proposed. We recommend that the council do signify its approval of the works referred to in the notice of the vestry of St. Pancras, dated April 4th, 1892, under the provisions of the St. Pancras (Middlesex) Electric Lighting Order, 1883.

We have also to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:—

From the Kensington and Knightsbridge Electric Lighting Company—March 25th, 1892, to 5, Edinburgh Terrace; March 29th, 1892, to 95, Gloucester Road.

From the London Electric Supply Corporation—March 31st, 1892, to 51, High Street, Deptford; April 1st, 1892, to 139, Regent Street.

From the St. James and Pall Mall Electric Light Company—March 31st, 1892, to 10, Duke Street; 50, Jermyn Street; April 4th, 1892, to 57 and 58, Regent Street.

From the House-to-House Electric Light Supply Company—March 30th, 1892, to 21, Gledhow Gardens; 51, Redclyffe Gardens; March 31st, 1892, to 245, Cromwell Road; 81, Onslow Square; 9, Redclyffe Square; April 2nd, 1892, 2, Collingham Gardens.

The following was submitted at the meeting held on Tuesday:—

Electric Lighting—Applications for Provisional Orders.

The council, on April 12th, approved, subject to certain amendments, the form in which the Board of Trade proposed to issue the order applied for by the Vestry of Lambeth. We have now to report, for the council's information, that the board has since intimated that these amendments have been adopted, and also that some minor amendments, which do not materially concern the council, have been made in this and the other orders applied for by local authorities.

The Board of Trade has forwarded, for the council's observations, a copy of the electric lighting order applied for by the Vestry of Shoreditch, in the form in which the board proposes to issue it. This has been carefully examined by us, and the only amendment which appears to be necessary is that in clause 2 should be inserted the usual definitions of the words "subway" and "plans." We recommend that the Board of Trade be informed that, subject to the above amendments, the council approves of the form in which the board proposes to issue the order applied for by the Vestry of Shoreditch.

The board has also forwarded, for the observations of the council, a copy of each of the three following orders (not promoted by local authorities), in the form in which the board proposes to issue it, namely, (*a*) County of London, North, (*b*) Southwark, and (*c*) Wandsworth. Having carefully examined these orders, we find that they substantially follow the model issued by the board in November, 1891; but we are of opinion that in the first-named the name of the council should be inserted in line 8 of clause 23, relative to the revocation of the order, and that in the same clause in all three orders authority should be given to the council and the local authority to make representations and objections with reference to proposed revocations. It is also necessary that it should be made clear that Wandsworth and Putney bridges are excluded from the area of supply under the Wandsworth order. We recommend that the Board of Trade be informed that, subject to the amendments above referred to, the council approves of the form in which the Board proposes to issue the County of London (North), the Southwark and the Wandsworth Electric Lighting Provisional Orders.

Notices under Electric Lighting Acts and Orders.

We have considered a notice dated March 31st, 1892 (received on April 25th), from the Electricity Supply Corporation, of intention to lay mains and to construct street-boxes in St. Martin's Court and Cecil Court. To these proposed works, which are of the same description as those of this company previously approved by the council, we see no objection; and we recommend that the sanction of the council be given to the works referred to in the notice, dated March 31st, 1892, of the Electricity Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work, and that the brick-work of the street-boxes shall be 9 inches thick.

We have also considered a notice dated April 26th, 1892, from the St. James and Pall Mall Electric Light Company of intention to lay mains in bitumen casing or iron pipe in Park Place, St. James's Street. There appears to be no objection to what is proposed; and we recommend that the sanction of the council be given to the works referred to in the notice, dated April 26th, 1892, of the St. James and Pall Mall Electric Light Company, upon condition that the company

do give two days' notice to the council's chief engineer before commencing the works.

We have also to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:—

From the London Electric Supply Corporation—April 9th, 1892, to 35, Brewer Street; April 27th, 1892, to 33, St. George's Place.

From the St. James and Pall Mall Electric Light Company—April 11th, 1892, to 4, Clifford Street; 4, Sackville Street; April 26th, 1892, to 140, Regent Street; 24, Shaftesbury Avenue.

NEW PATENTS—1892.

7,361. "Improvements in the distribution of electricity by alternate currents." W. L. Spence and B. Deakin. Dated April 19th.

7,398. "Improvements in telephone receivers." E. C. Hess. Dated April 19th. (*Complete.*)

7,404. "Improvements in or relating to electric railways and to dynamo machines and motors." S. H. Short. Dated April 19th. (*Complete.*)

7,412. "An improved battery element." Sir C. S. Forbes, Bart. Dated April 19th.

7,415. "Improvements in and relating to electric railways." M. W. Dewey. Dated April 19th. (*Complete.*)

7,466. "Improvements in electrical communication on railway trains." A. Shiels. Dated April 20th.

7,487. "Improvements in electric switches." W. A. S. Benson. Dated April 20th.

7,488. "Improvements in electric arc lamps." H. Tipping. Dated April 20th.

7,492. "Improvements in and connected with electric bells." H. Oppenheimer. Dated April 20th.

7,509. "Improvements in alternating current electro-magnetic motors and method of operating the same." H. H. Lake. (Communicated by W. Stanley, jun., and J. F. Kelly, United States.) Dated April 20th. (*Complete.*)

7,515. "Improvements in electric insulating composition." T. Griffiths. Dated April 20th.

7,569. "Improvements in apparatus for automatically operating electric lamp switches." P. Everitt. Dated April 21st.

7,570. "Improvements in insulators for electric installations." W. T. Sugg. Dated April 21st.

7,593. "Improvements in frieze and cornice borders and dado decorations for electric fittings." Sir W. Vavasour. Dated April 22nd.

7,629. "An electrically propelled canoe." C. E. Masterman and Woodhouse and Rawson United, Limited. Dated April 22nd.

7,646. "Improvements in electric switches or contact makers." H. A. Mavor, W. A. Coulson, S. Mavor, and W. B. Sayers. Dated April 22nd.

7,655. "Improvements in electrical call and indicating apparatus." G. R. Nunn. Dated April 22nd.

7,682. "An improvement in electromotors, applicable also to dynamo-electric machines." F. Price. Dated April 23rd.

7,690. "Improvements in electromotors." J. A. Kingdon. Dated April 23rd.

7,717. "Improvements in electric alarm apparatus for use in connection with railways and vehicles, or trains travelling thereon." W. L. Wise. (Communicated by D. Murguletz, Roumania). Dated April 23rd.

7,718. "Improvements in or connected with electric arc lamps." W. H. Akester. Dated April 23rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

1,599. "Improvements in apparatus for stopping any water-wheel or other motor used in generating electricity." W. S. Elliot. Dated January 29th. The inventor uses a governor driven from a main shaft, and which has a cam attached to the arms for carrying the balls. This cam works on the centre or driving spindle of the governor, and moves up and down with the governor arms as the speed of the motor increases or diminishes. When the speed is increased, the cam rises to a certain point where, owing to its shape, it shifts a loose clutch to one side. This causes a central horizontal shaft to revolve, and this again acting on a screw, lowers the sluice or closes the valve until there is sufficient water or steam shut off to bring the motor to its normal speed. In order to increase the speed of the motor a switch or other arrangement for breaking connection at the distant end where the current is being used, is turned, thus at once taking the weight of work off the dynamo. The motor being relieved, immediately increases its speed, and the governor cam, as described, rises to the highest point. 1 claim.

5,508. "An improved method of electro-plating wire." T. L. Hemming. Dated March 31st. Claims:—The process of electro-plating wire by revolving drums or swifts immersed in the plating liquid. An electro-plating tank in combination with the movable slides and the fixed driving mechanism, as described with reference to the drawings. The bearings or movable slides forming bearings, as described with reference to the drawings. The swift, or drum with metal conductors, for conveying the electric current to the wire under operation with reference to the drawings.

5,963. "An electric 'hooter' or loud sound producing apparatus." H. A. C. Saunders and A. C. Brown. Dated April 7th. Has reference to apparatus for producing, by means of the electro-magnetic vibration of a diaphragm, a very loud sound capable of use for various signalling and other purposes, for instance, in those places where a steam whistle, bell, horn, siren or detonating signal is at present employed. It consists in causing such diaphragm to form one side or wall of an airtight, or nearly airtight, chamber, over which it can vibrate. By this means the sound is greatly increased. 4 claims.

6,378. "Improvements in and relating to electric motors." C. J. Van Depoele. Dated April 14th. According to the present invention, reciprocating motors, desirably of the three-cylinder type, are connected directly with a crank upon the axle to be driven, and being supported concentric therewith, no intermediate or intervening connections are required, since the pistons of the reciprocating engines from which the power is communicated directly to the work are capable of being moved at any desired speed, whether fast or slow. 1 claim.

8,141. "Improvements in or relating to treating or manufacturing certain forms of insulated electric conductors." W. P. Thompson. (A communication from abroad by J. B. Williams, of California.) Dated May 12th. Consists briefly of the combination, with a central conductor substantially circular in cross section, of a surrounding dielectric and an intermediate covering or separating device placed between the conductor and the dielectric, whereby they are separated, and air spaces or passages formed between them. 3 claims.

8,555. "Improvements in insulated electric conductors." W. P. Thompson. (A communication from abroad by J. B. Williams, of America.) Dated May 19th. Consists primarily in interposing isolated or non-communicating air spaces between the dielectric and the conductor, by means of what may be called a "separating" device, whereby the efficiency of the insulation is materially increased. 4 claims.

8,183. "An improved electric alarm and announcing clock for hotels and factories." H. D. Fitzpatrick. (Communicated from abroad by S. Schubardt, of Germany.) Dated May 13th. The new invention is distinguished by a clockwork, the dial plate of which is fitted with any number of contact pins, to be combined as required. The hour hand of the clock has an extension piece with a flexible or spring point, which, in going round, touches one or several of the contact pins. By this means bells may be rung either in a single distant room, or, at the same time, in any number of rooms at the hour indicated by the contact pins. 3 claims.

8,540. "Improvements in conductors for electric railways." T. J. Moore and E. A. Warren. Dated May 19th. Relates to improvements in conductors for electric railways, and the object is to provide means whereby an electric current, taken from any suitable source of supply, may be conveyed to the motor on the car through electric connections, which will permit the passage of the current from the conductor to the motor through the usual trolley, and connections only at the points of contact between the trolley and the conductor, and in certain positions of the latter, the conductor being normally inactive, or "dead," and incapable of conveying current at any point in its length, except the immediate point of contact between the same and the trolley, and at a time when the conductor is elevated or thrown out of its normal position. 6 claims.

8,575. "Improved methods of and apparatus for generating and utilising electric energy for lighting purposes." Nikola Tesla. Dated May 19th. Relates to the production of the electric light by currents of very great frequency. 9 claims.

8,648. "Improvements connected with the use of compressed air for producing electric light and cold." E. Bazin. Dated May 20th. The arrangements for producing electric light and cold simultaneously consist of a compressed air engine driving a dynamo for supplying current to electric lamps, and the exhaust from which produces, by reason of the expansion of the air, the cold to be utilised in safes, cold store rooms, concentrators of cold and other places where it is desired to obtain a low temperature. 4 claims.

8,922. "Improvements in electric clocks." H. S. Prentiss. Dated May 28th. Consists essentially in combining with a series of secondary clocks, a primary clock or a transmitter having an incorporated synchronising device for sending repeated impulses through the secondary clocks at the expiration of the synchronising period. 20 claims.

8,924. "Improvements in fuse-blocks for electric circuits." H. H. Lake. (Communicated from abroad by H. S. Kaliske, of America.) Dated May 26th. The object of the invention is to combine with an electric circuit a fuse block, of such a nature, that when one fuse burns out, another already in the box may, by a slight movement of the box, be brought into the circuit, and that this substitution of a new fuse for a burnt one may be repeated many times. 2 claims.

9,436. "An electrical transformer." A. D. Williamson. Dated June 3rd. Claim:—An electrical transformer consisting of four sets of iron plates of approximately U-shape, grouped together in form of a cross, the four sets of their internal limbs enclosed together within a bobbin of thick wire, and the four sets of their external limbs enclosed separately in bobbins of fine wire, substantially as described.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

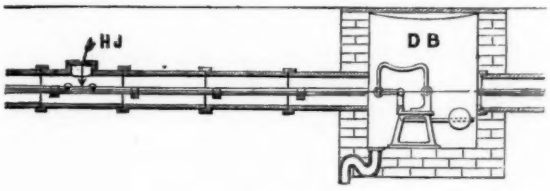
WHEN will the Exhibition be closed? It is a matter of doubt. Seeing, however, that two or three new exhibitors have appeared on the scene, it would not seem probable that it is going to close immediately. Prominent among the new comers is the Ferranti armature which stands opposite the great organ. As is generally known, the armature in the Ferranti machine is the moving part. The coils consist of copper strip wound on to a gun metal block, insulating material being placed between the windings; it is fixed into an ebonite cap, which binds the coils securely to the centre disc. An interesting addition to the Brush Company's stand in the nave is a Mordey ring armature 10 feet high; the machine of which this is part is intended for the City lighting, and is made to have a capacity of 200 kilowatts.

Messrs. Lloyd and Lloyd, of Birmingham, show in the machinery annexe many specimens of joints welded by the Benardos process; the only regret is that the process is not occasionally shown in working.

In connection with conductors, there are several systems shown at the Palace. Messrs. Crompton & Co. show in the machinery hall a complete fit-up of their well-known method of street mains. Leaving for the moment, this, as well as the system shown by Messrs. Siemens Brothers, we will draw attention to the means of laying underground conductors adopted by Mr. Wilson Hartnell.

Hartnell's System of Underground Conductors.

One of the primary advantages claimed when using this method is its comparative cheapness. The wires are placed in pipes of special forms, the pipe being wholly or partially divided into several channels. Thus, for the three-wire system, the pipe may be rectangular, as at fig. 2, with partial divisions or ribs projecting on each side. These carry a series of transverse



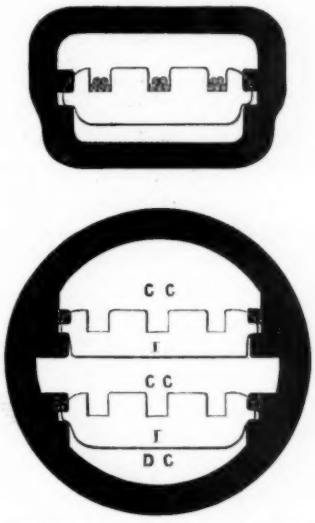
H J, House Junction; D B, Draw Box.

FIG. 1.

insulators placed at suitable intervals, on which the bare conductors are placed, and divide the pipe into three channels. The lower channel is for drainage, for although every precaution may be taken to exclude water or moisture, yet in case of its accidental entrance, its ejection must be provided for. The central channel is occupied by the insulators and conductors themselves. The upper channel is provided for the carrier, which may be a piece of wood to which is attached the ends of conductors that have to be drawn into their places. The carrier itself is pulled through the upper channel by a draw wire. If no draw wire was left in the pipes the carrier may be pushed through by a flexible rod with screwed joints and thus insert its own draw wire. The conductors themselves may also be used to pull the carrier through with its attached draw wire. Thus the conductors can at any time be removed, replaced or added to, as desired. The distance through which a carrier and draw wire may be inserted is not necessarily limited to the length of a push rod, since it is easy to propel the carrier any distance by means of an electric motor attached to it, but such mechanism will rarely be required.

The connections from mains to the houses when short and of small size are most conveniently made of insulated wire, as usual. The house junction pipe is like the other pipes, but provided with a cover with one or more junction holes at the side, through which the house wires may pass. These junction holes must of course be made water-tight. It will be seen that the carriers can pass unimpeded through the junction boxes. The draw boxes for inserting or removing the conductors may be made of earthenware or of brick or stone, set with cement. They must be placed at convenient intervals and be sufficiently large when considerably below the surface for a man to work in them. The junction boxes for side streets need only be T pipes or crosses with covers, unless they are made into draw boxes. The provision for

FIG. 2.



C C, Carrier channel; I, Insulators; D C, Drainage channel.

FIG. 3.

drainage must depend upon local conditions. Under some circumstances the draw boxes may be connected through suitable traps to the sewers. When the pipes are considerably inclined, the bottoms of the draw boxes may be made flush with the bottoms of the pipes and drainage exits provided only at long intervals. Where the sewers are liable to occasional floods, the usual back valves may be provided to prevent the entrance of the water from the drains. Where a connection with the sewers is unadvisable, some of the draw boxes may be considered as sumps, and means taken to pump them out by hand or electric motor. Under favourable conditions, however, it should be made impossible for any water to enter the pipes. The insulating bridges are pushed along the carrier channel until they fall into the recesses prepared for them, and leave the carrier channel free. These bridges may be made to carry one, two or three, or more independent conductors, and they may be placed in two or more tiers, so as to carry any desired number of conductors. A conductor channel must be provided over each tier of bridges. The pipes may be jointed with good puddled clay as prepared for making plastic bricks; where this is not available cement may be used.

The conductors may be of copper strips for the larger mains and copper cables stranded or flat plaited, or copper wires for the smaller, the latter are the most easily handled. Flexible conductors must be held in place by tension. Provision may sometimes be made to maintain uniform tension by means of weighted levers or springs when the insulators are placed far apart; when the insulators are close, copper strips will require no tension. As the conductors are in the air resting on insulators only, the insulation is very high. Should a wire touch the pipe through any accident, the

insulation will still be good enough to continue working as the pipes themselves are well glazed.

Although these pipes and insulators are to enable bare copper wire to be used for the mains and main branches, they are also useful for carrying insulated wire. The insulation is improved, the wires are protected, and they are easily accessible, each in its own channel, by means of the carrier channel. When a system of bare conductors is being laid, there still may be places where, from liability to flood, settlements of the ground or other causes, it may be advisable to use cables more or less insulated. These pipes are especially economical with low tension current, because with these the weight of the conductors per yard is at a maximum as compared with the energy conveyed.

Thus three parallel insulated conductors would cost about £4,020 for one mile. But three equal bare conductors would only cost £1,356, and if the pipes protecting them cost £864, the total £2,020 shows a saving of £1,800 per mile.

This system not only renders low tension and direct distribution financially practicable where otherwise impossible, but it effects a further financial convenience. When the pipes are laid, no greater expense need be incurred for conductors than present circumstances require—as business increases, the conductors may be increased in area or number.

With high tension it will, however, be generally less expensive to use bare wire in these pipes for the mains, than insulated wires protected by any other system.

For very high tensions, such as are likely to be used for the conveyance of power, these pipes are well adapted, since by these means the public is perfectly protected. At the same time, by using special insulation, such as resin oil insulators on the bridges, a very high and durable insulation is obtained.

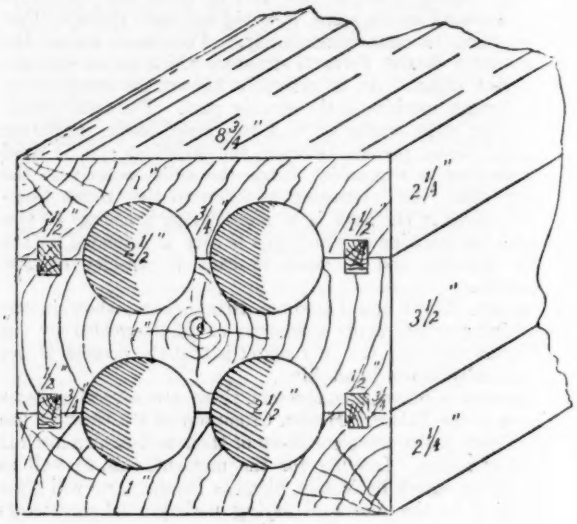


Fig. 1.

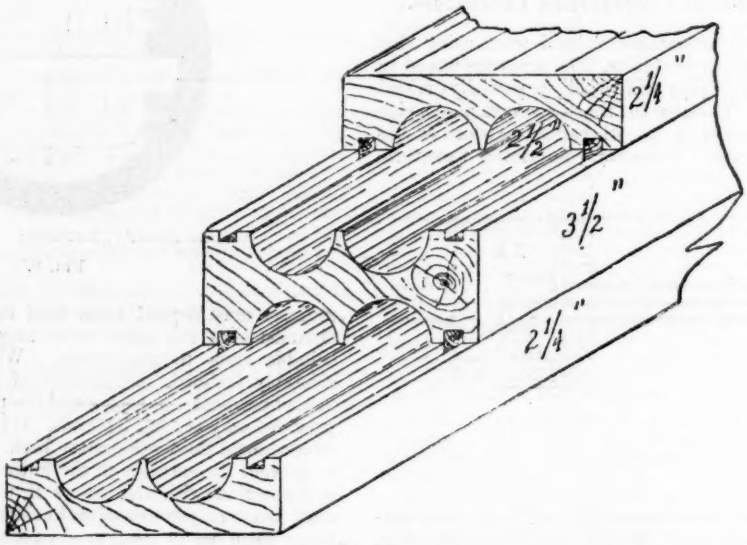


Fig. 2.

The Macdonald Subway Electrical Conduit.

The engineers who visited the Electrical Exhibition which was held at Philadelphia in 1884, will remember the very large number of schemes for carrying electric light cables underground which were then put forward. The committee who reported on the various conduits exhibited, wisely refrained from giving a definite opinion as to their relative merits, but recommended almost every design for trial, and in a short time there were almost as many systems of electrical conduits and tubes undergoing trial in the streets of Philadelphia and New York, as there were of arc lamps and dynamos. This highly practical method of trial has resulted in the survival of the fittest, among which is the Macdonald subway, which still remains as originally laid down in Philadelphia nearly seven years ago.

The accompanying drawings, figs. 1 and 2, clearly illustrate the system which, when laid, resembles the Callender-Webber, with the advantage that the joints are bonded together, and that additions or connections can be made rapidly by simply opening the conduit, and building it up again. The ducts are 2½ inches in diameter, and are cut out of planks 14 feet in length; the figs. 1 and 2 show four ducts, but any number can be obtained, according to the requirements, by simply adding centre pieces.

The labour of laying is reduced to a minimum, as all the fastenings being perpendicular, the conduit can be laid in a trench of its own width, each piece fitting the other; the tongues in the sides act as protectors against the admission of water, and the creosote with which the timber is dressed repels all moisture; a 1½-inch plank is placed on the top to defend the conduit against future excavations. The material generally used is yellow pine, creosoted and specially treated, so as to remove all traces of the phenol which is at first present in the creosote, and which alone is found to have an effect on lead-covered cables.

The system is exhibited at the Crystal Palace, Stand No. 214A. In this country it has been practically tested by Mr. W. H. Preece, and approved for telephone cables. Mr. K. Hedges, C.E., has also made some lengthy experiments with samples of the conduit which were sent from America, and his favourable report has caused Messrs. Edward Spencer & Co., timber merchants, of 87, Fenchurch Street, to erect special machinery for manufacturing the conduit in this country, and supplying it at a price which will enable it to compete successfully with the systems which are more generally known.